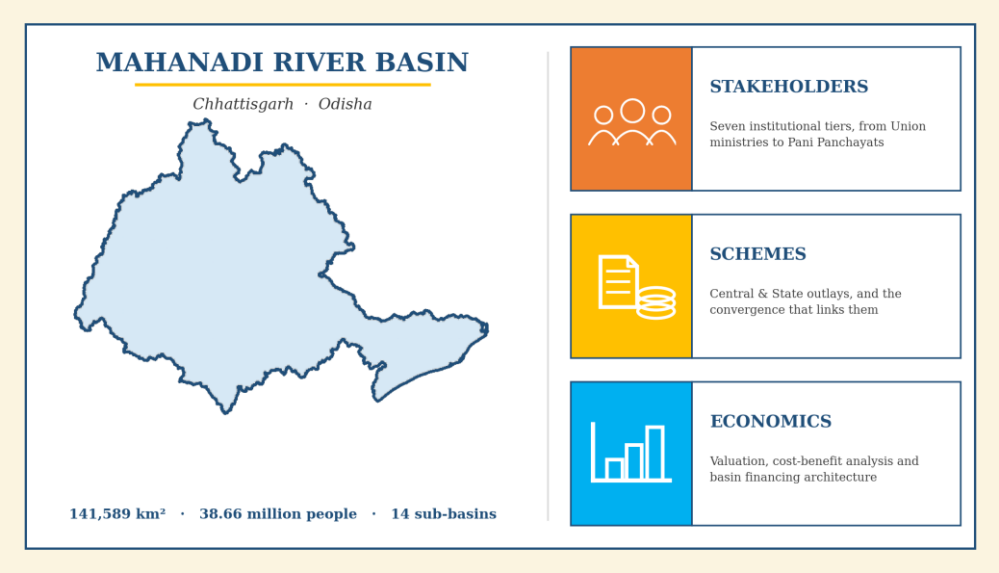
National River Conservation Directorate
Ministry of Jal Shakti,
Department of Water Resources,
River Development & Ganga Rejuvenation
Government of India

Mapping of Various Stakeholders, Schemes, and Economics Involved



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Ninth Quarter Consolidated Report on cMahanadi

Mapping of Various Stakeholders, Schemes, and Economics Involved

National River Conservation Directorate (NRCD)

The National River Conservation Directorate, functioning under the Department of Water Resources, River Development & Ganga Rejuvenation, and Ministry of Jal Shakti providing financial assistance to the State Government for conservation of rivers under the Centrally Sponsored Schemes of 'National River Conservation Plan (NRCP)'. National River Conservation Plan to the State Governments/ local bodies to set up infrastructure for pollution abatement of rivers in identified polluted river stretches based on proposals received from the State Governments/ local bodies.

www.nrcd.nic.in

Centres for Mahanadi River Basin Management and Studies (cMahanadi)

The Center for Mahanadi River Basin Management and Studies (cMahanadi) is a Brain Trust dedicated to River Science and River Basin Management. Established in 2024 by NIT Raipur and NIT Rourkela, under the supervision of cGanga at IIT Kanpur, the center serves as a knowledge wing of the National River Conservation Directorate (NRCD). cMahanadi is committed to restoring and conserving the Mahanadi River and its resources through the collation of information and knowledge, research and development, planning, monitoring, education, advocacy, and stakeholder engagement.

www.cmahanadi.org

Centres for Ganga River Basin Management and Studies (cGanga)

cGanga is a think tank formed under the aegis of NMCG, and one of its stated objectives is to make India a world leader in river and water science. The Centre is headquartered at IIT Kanpur and has representation from most leading science and technological institutes of the country. cGanga's mandate is to serve as a think tank in the implementation and dynamic evolution of the Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this, it is also responsible for introducing new technologies, innovations, and solutions into India.

www.cganga.org

Aknowledgment

This report is a comprehensive outcome of the project jointly executed by NIT Raipur (Lead Institute) and NIT Rourkela (Fellow Institute) under the supervision of cGanga at IIT Kanpur. It was submitted to the National River Conservation Directorate (NRCD) in 2024. We gratefully acknowledge the individuals who provided information and photographs for this report.

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Abbreviations and Acronyms

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BCM	Billion Cubic Metres
BCR	Benefit-Cost Ratio
CAMPA	Compensatory Afforestation Fund Management and Planning Authority
CBA	Cost-Benefit Analysis
CECB	Chhattisgarh Environment Conservation Board
CGWB	Central Ground Water Board
cMahanadi	Centre for Mahanadi River Basin Management and Studies
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organisation
CSR	Corporate Social Responsibility
CSS	Centrally Sponsored Scheme
CWC	Central Water Commission
DMF	District Mineral Foundation
DoWR	Department of Water Resources
DPR	Detailed Project Report
EC	Environmental Compensation
ESIP	Ecosystem Services Improvement Project
FC	Finance Commission
FRA	Forest Rights Act, 2006
FSSM	Faecal Sludge and Septage Management
GVA	Gross Value Added
HAM	Hybrid Annuity Model
H&UDD	Housing and Urban Development Department (Odisha)
IRBM	Integrated River Basin Management
IRR	Internal Rate of Return
ISRWD Act	Inter-State River Water Disputes Act, 1956
JICA	Japan International Cooperation Agency
JJM	Jal Jeevan Mission
LULC	Land Use and Land Cover
MCM	Million Cubic Metres
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MLD	Million Litres per Day
MoEFCC	Ministry of Environment, Forest and Climate Change
MoHUA	Ministry of Housing and Urban Affairs
MoJS	Ministry of Jal Shakti
MRB	Mahanadi River Basin
MWDT	Mahanadi Water Disputes Tribunal
NGT	National Green Tribunal
NMCG	National Mission for Clean Ganga
NPV	Net Present Value
NRCD	National River Conservation Directorate
NRCP	National River Conservation Plan
NRW	Non-Revenue Water
O&M	Operation and Maintenance
ODF	Open Defecation Free
OIIPCRA	Odisha Integrated Irrigation Project for Climate Resilient Agriculture
OSPCB	Odisha State Pollution Control Board
OWSSB	Odisha Water Supply and Sewerage Board

PES	Payment for Ecosystem Services
PHED	Public Health Engineering Department
PMKKKY	Pradhan Mantri Khanij Kshetra Kalyan Yojana
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PPP	Public-Private Partnership
PRI	Panchayati Raj Institution
RACI	Responsible, Accountable, Consulted, Informed
RBA	River Basin Authority
RRC	River Rejuvenation Committee
SBM	Swachh Bharat Mission
SeTP	Septage Treatment Plant
SHG	Self-Help Group
SLB	Service Level Benchmarking
STP	Sewage Treatment Plant
SUDA	State Urban Development Agency
TEV	Total Economic Value
ULB	Urban Local Body
WATCO	Water Corporation of Odisha
WRD	Water Resources Department
WUA	Water Users' Association

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Executive Summary

This report maps the actors, the public schemes, the economic value, and the financing and governance arrangements that together determine the fate of the Mahanadi River Basin - a 141,589 km² system spanning Chhattisgarh and Odisha that supports about 38.66 million people, receives 1,291 mm of average annual rainfall, and generates an average annual runoff of 66.8 BCM of which roughly 50 BCM is considered utilisable [21]. It is the third volume in the cMahanadi series, following the Revenue Map Report and the Infrastructure and Planning Report, and is designed to be used operationally rather than read descriptively.

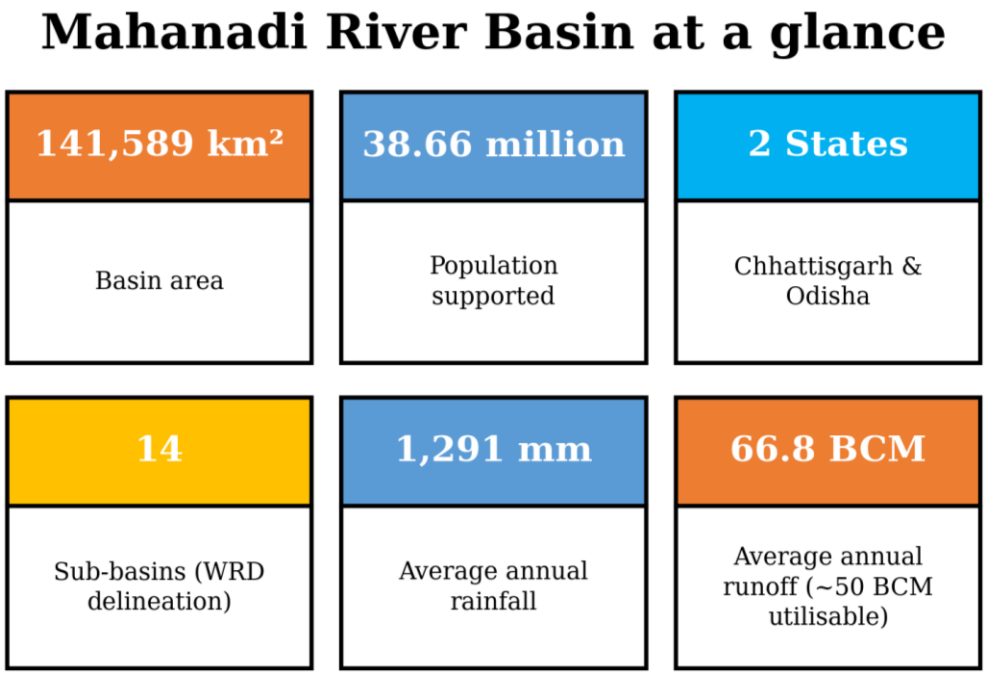


Figure 1 Mahanadi River Basin at a glance

Stakeholders

The report identifies and classifies institutional actors across seven tiers: Union ministries and central regulatory bodies; two State Governments with parallel but non-identical departmental architectures; basin- and project-level bodies; urban and rural local governments; community institutions including Pani Panchayats, Water Users' Associations, Forest Rights Act gram sabhas and self-help groups; the private sector, dominated in this basin by thermal power, steel, aluminium, cement and coal mining; and development finance institutions, academia and civil society. An influence-interest analysis reveals a structural asymmetry that explains much of the basin's governance difficulty: the actors with the highest stake in river condition - tail-end farmers, fisherfolk, delta communities and forest-dwelling households - sit almost entirely in the low-influence quadrants, while the actors with the greatest influence over allocation decisions face the weakest incentives to internalise downstream cost. Five recurring conflict axes are mapped: inter-state (Chhattisgarh–Odisha), inter-sectoral (agriculture–industry),

spatial (head-reach–tail-end), vertical (state–local), and temporal (present abstraction versus future assimilative capacity).

Schemes and convergence

Central and state schemes with a bearing on basin outcomes are inventoried with their verified outlays, mission periods and cost-sharing structures. The headline finding is that the Mahanadi Basin is not primarily short of scheme money; it is short of scheme coherence. Jal Jeevan Mission was restructured in 2025 with an enhanced outlay of ₹8.69 lakh crore to December 2028, of which ₹3.59 lakh crore is central assistance [5]; AMRUT 2.0 carries ₹2,99,000 crore and SBM-Urban 2.0 ₹1,41,600 crore [4]; the Fifteenth Finance Commission tied ₹1,42,084 crore of panchayat grants specifically to water and sanitation over 2021-26 [7]; and District Mineral Foundations in the two basin states had together accumulated roughly ₹20,879 crore - ₹13,728 crore in Odisha and ₹7,151 crore in Chhattisgarh - of which at least 70 per cent is mandated to high-priority sectors including drinking water, sanitation and environment [8]. Against this, the entire National River Conservation Plan has sanctioned ₹8,970.51 crore nationally across 58 rivers in 100 towns of 17 states since inception, creating 3,019 MLD of treatment capacity [2].

the two basin States hold on the order of ₹32,000 crore in funds derived from extractive industry and earmarked to environmental and area-development purposes, roughly three and a half times the entire national NRCP sanction since inception, sitting in precisely the districts that constitute the basin's most degraded sub-basins.

The operational implication is direct: a river-conservation strategy that relies on NRCP as its principal funding source is planning against the smallest purse in the room. NRCP's comparative advantage is not its balance sheet but its mandate - it is the only instrument in the list whose objective function is river condition itself. It should therefore be used to direct, sequence and quality-assure the far larger flows that are already reaching the basin for adjacent purposes. The report proposes a four-axis convergence architecture (vertical, horizontal, spatial and temporal) and works through specific convergence combinations that can be ordered without new legislation.

Economics and valuation

The economic chapter establishes a Total Economic Value framework and then a damage-cost and intervention-cost framework built entirely on published unit rates, so that the numbers can be defended in appraisal. Three anchors carry most of the analytical weight. First, the National Green Tribunal's environmental compensation formula - ₹2 crore per MLD of untreated sewage and ₹300 per metric tonne of unremediated legacy solid waste [10] - which converts a service gap into a liability expressed in rupees and is already being applied to these States. Second, the CPCB's benchmark of ₹2.50 crore per MLD as the average capital cost of primary, secondary and tertiary sewage treatment, excluding O&M [3]. Third, the World Bank's national estimate that environmental degradation costs India about 5.7 per cent of GDP, with water-pollution-related health costs alone of ₹470–610 billion a year [9].

Placed side by side, the first two anchors produce a result that should reframe how sewage projects are argued in State finance departments. The compensation assessed for failing to treat

one MLD of sewage (₹2 crore) is of the same order as the capital cost of building the capacity to treat it (₹2.50 crore). The cost of non-compliance is therefore roughly 80 per cent of the cost of compliance - except that compliance produces an asset with a thirty-year service life together with health, agricultural, fisheries and ecosystem benefits, while the compensation produces nothing. Sewage treatment in this basin does not need to be justified on environmental grounds alone; it can be justified as avoided liability.

Four illustrative cost-benefit analyses demonstrate the method at 8 and 12 per cent social discount rates over a 30-year horizon: municipal sewage treatment, nala (Narva) watershed treatment, legacy solid waste remediation, and catchment and riparian restoration. Because several benefit streams cannot be valued from verified Indian sources, the analyses are reported as switching values - the threshold each unvalued benefit must reach for the intervention to break even - rather than as single-point benefit-cost ratios. This is deliberate: a switching value can be checked against local conditions, whereas a point estimate resting on an unsourced assumption cannot.

Two results stand out. Watershed treatment, costed on Chhattisgarh's own delivered programme at about ₹5,256 per hectare, breaks even at an incremental benefit of roughly ₹572 per hectare per year - a threshold so low that almost any measurable agricultural or recharge gain clears it, before counting the 50lakh person-days of employment the programme already generated [21]. Municipal sewage treatment, by contrast, does not break even on quantified avoided-liability and health benefits alone under central assumptions; it requires treated-water reuse revenue in the range of roughly ₹0.9 to ₹6.2 per cubic metre depending on O&M intensity and discount rate. Since industrial water is generally purchased well above that range, the finding is not that sewage treatment is uneconomic but that its economics depend on being designed with a reuse offtake from the outset rather than as a disposal facility.

Funding models and governance

Seven financing models are assessed against six criteria and matched to intervention types. No single model suits the basin. The report proposes a layered Mahanadi Basin Financing Architecture in which budgetary and Finance Commission flows fund network and rural assets; the Hybrid Annuity Model and One City One Operator structures - first proven in the Indian water sector under Namami Gange, where the public share is 40 per cent during construction and the balance is paid as annuities over fifteen years alongside O&M [13] - fund treatment assets in the larger basin towns; municipal green bonds, following the Ghaziabad (₹150 crore, 2021), Indore (₹244 crore, 2023), Ahmedabad (₹200 crore) and Vadodara (₹100 crore) precedents [14], fund creditworthy ULB projects; and a ring-fenced basin fund drawing on DMF, CAMPA and CSR finances catchment and community works that no commercial structure will support.

The governance chapter sets out the constitutional position - water is a State subject under Entry 17 of the State List, qualified by Entry 56 of the Union List - and traces the resulting fragmentation. Two developments make this report timely. The Mahanadi Water Disputes Tribunal, reconstituted under Justice Bela M. Trivedi, has set a final settlement deadline for the two States, failing which it will deliver a binding award [15]. And the Sixteenth Finance Commission report, tabled in Parliament on 1 February 2026, recommends ₹9.47 lakh crore in

grants over 2026-31 but discontinues the sector-specific and state-specific grant windows used by its predecessor [6]. The second change removes a funding route the basin might otherwise have used, and makes the case for convergence and for own-source municipal revenue considerably more urgent than it was under the Fifteenth Commission.

Recommendations

The report closes with a phased institutional roadmap. Phase I (0–2 years) creates a Mahanadi Basin Coordination Cell under existing executive authority, requiring no legislation, together with a shared basin data platform and a standing convergence protocol. Phase II (2–5 years) establishes a Mahanadi River Basin Organisation with statutory backing, drawing on the two-tier Governing Council and Executive Board structure proposed in the Draft River Basin Management Bill, 2018, which named the Mahanadi among thirteen basins for such authorities [16]. Phase III (5–15 years) transitions to full Integrated River Basin Management, with basin-level allocation, a functioning water accounting system, and economic instruments operating at scale. Each phase carries defined milestones, responsible agencies, enabling actions and identified risks.

1. Introduction and Objectives

1.1 Context

The Mahanadi is one of the major east-flowing inter-State rivers of peninsular India. It rises at about 442 m above mean sea level near Pharsiya village in Dhamtari district of Chhattisgarh, runs 851 km - 357 km in Chhattisgarh and 494 km in Odisha - and forms a large deltaic region in Cuttack and Puri districts before discharging into the Bay of Bengal. The basin covers approximately 141,589 km², of which 73,214 km² lies in Chhattisgarh, 65,847 km² in Odisha, and 2,528 km² across Jharkhand, Maharashtra and Madhya Pradesh; about 99 per cent of the basin therefore lies within the two principal basin States [21].

Table 1 The fourteen sub-basins of the Mahanadi River Basin (WRD delineation)

Sub-basin	Principal State	Area (km²)	Share of basin	Dominant pressure on river condition
Seonath	Chhattisgarh	30,950.00	21.4%	Urban sewage from Raipur, Bilaspur and Durg; paddy monoculture
Tel	Odisha	22,890.20	15.9%	Upland agriculture, gully erosion, drought exposure
Site of Hirakud Reservoir to Mundali Weir	Odisha	19,596.60	13.6%	Reservoir regulation; thermal power and industrial abstraction
Origin to the site of Hirakud Reservoir	Chhattisgarh	17,500.20	12.1%	Gangrel Dam regulation; upper-catchment paddy runoff
Ib	Odisha / Chhattisgarh	12,575.00	8.7%	Open-cast coal mining; suspended solids and metals
Hasdeo	Chhattisgarh	9,918.09	6.9%	Minimata Bango regulation; Korba thermal power; forest loss
Directly draining from Naraj to sea	Odisha	6,537.83	4.5%	Municipal sewage from Cuttack and Bhubaneswar; delta salinity
Mand	Chhattisgarh	5,329.12	3.7%	Coal mining expansion in the Mand-Raigarh belt
Ong	Odisha	5,145.60	3.6%	Rainfed agriculture; soil erosion
Chilka (including Daya)	Odisha	5,004.26	3.5%	Eutrophication; freshwater-saline lagoon interface
Jonk	Chhattisgarh / Odisha	3,455.47	2.4%	Upland forest and rainfed agriculture
Pairi	Chhattisgarh	3,242.60	2.2%	Forest and agricultural runoff
Kelo	Chhattisgarh / Odisha	1,338.79	0.9%	Industrial and urban discharge near Raigarh
Mundali Weir to Naraj, including Sapua catchment	Odisha	929.08	0.6%	Delta-head hydraulic structure regulation
Total	-	**144,412.80**	**100.0%**	-

Source: Sub-basin names and areas from the State Water Resources Department sub basin layer (MRB_Sub_ Basin_WRD) held by cMahanadi. Shares are computed against the layer total of 144,412.80 km², which differs from the Central Water Commission basin figure of 141,589 km² [1, 21] because the two delineations are drawn on different boundaries; the difference of about 2 per cent should be borne in mind when reconciling the two. Dominant pressures are the assessment of this report, drawn on the evidence in Chapters 2 to 4.

The two preceding volumes in this series characterised the basin in physical and administrative terms. The Revenue Map Report classified land across the sub-basins into forest, agricultural, fallow, net sown, built-up and non-cultivable categories for the decades 2000-01, 2010-11 and 2020-21, and documented the progressive fragmentation of holdings - average operational holding size in the Odisha portion of the basin fell from 0.803 ha in 2005 to 0.646 ha in 2010 and remained at that level in 2015, while in rural Chhattisgarh average holdings fell from 1.22 ha to 0.75 ha between 2005 and 2015 [22]. The Infrastructure and Planning Report documented the physical stock and its deficits: 253 dams and 24 barrages, weirs and anicuts recorded by the Central Water Commission; 74 major or medium irrigation projects; a gross irrigable area of 32.8 lakh hectares against a gross cropped area of 82.3 lakh hectares; and, on the sanitation side, roughly 600 MLD of sewage generated in Chhattisgarh as of March 2023 of which 70.23 per cent went untreated [21].

What neither volume attempted was a systematic account of who decides, through which instruments public money reaches the basin, what the resource is economically worth, and how interventions might be paid for. That is the subject of this report. The omission matters because the diagnosis in both earlier volumes converges on institutional rather than technical failure. Chhattisgarh irrigates only about 16 per cent of its cultivable land against an assessed potential of up to 75 per cent; Odisha has created irrigation capacity it does not fully use; both States report fragmented water governance, weak stakeholder participation and inadequate cost recovery [21]. These are not engineering problems.

For spatial analysis this report uses the fourteen sub-basins of the State Water Resources Department delineation held by cMahanadi, listed below. This is the unit at which convergence is proposed in Chapter 3 and at which expenditure tagging is recommended in Chapter 7, because it is the finest delineation that is both hydrologically meaningful and already adopted by the implementing departments.

1.2 The problem this report addresses

Three specific difficulties recur across the basin and motivate the structure of this volume.

Attribution failure. Where responsibility for a river outcome is divided among a State pollution control board, a public health engineering department, a municipal corporation, an urban development agency and a water resources department, no single agency owns the outcome. Non-compliance is then a coordination failure rather than a dereliction, and is correspondingly difficult to correct through enforcement alone.

Fiscal invisibility of the river. Very large sums reach the Mahanadi Basin every year through schemes whose objectives are drinking water, sanitation, irrigation, employment, afforestation or mining-area welfare. Almost none of this expenditure is accounted against river condition. A

rupee spent on a septage treatment plant in a basin town is recorded as sanitation expenditure, not as river-pollution abatement, and the resulting improvement in the receiving stream is therefore invisible to the fiscal system that paid for it. Consequently the basin appears chronically under-funded when it is in fact substantially funded but incoherently accounted.

Absence of a common economic metric. Water allocation decisions in the basin routinely pit a quantified benefit against an unquantified one. An industrial allocation carries an investment figure, an employment figure and a tax projection. The foregone downstream irrigation, the reduced dilution capacity, the fisheries impact and the delta salinity consequence carry no number at all, and therefore lose. Until the second set of values is expressed in the same units as the first, the outcome of such decisions is determined before the deliberation begins.

1.3 Objectives

1. To identify, classify and characterise the full set of stakeholders acting on or affected by the Mahanadi River Basin, and to assess their relative influence, interest and legal standing.

2. To compile a verified inventory of central and State schemes bearing on basin outcomes, with their outlays, periods, cost-sharing arrangements and implementing agencies.

3. To construct a convergence framework showing where scheme objectives, geographies and timelines overlap, and to identify specific convergence opportunities that are actionable under existing authority.

4. To establish the economic significance of the basin and to demonstrate defensible methods for valuing both the resource and the damage to it, using published unit rates.

5. To conduct illustrative cost-benefit analyses of representative intervention classes, with explicit assumptions and sensitivity testing.

6. To assess alternative funding models against the basin's specific institutional and fiscal conditions, and to propose a layered financing architecture.

7. To map the existing governance architecture, allocate roles and responsibilities against a defined timeline, and propose a phased institutional roadmap toward Integrated River Basin Management.

1.4 Scope and approach

The geographic scope is the Mahanadi River Basin as delineated by the Central Water Commission, analysed at sub-basin level where data permit. The analytical unit for stakeholder and governance mapping is the institution; for scheme mapping it is the scheme-year; and for economic analysis it is the intervention class rather than the individual project, since project-level appraisal requires site-specific Detailed Project Reports that lie outside the scope of a basin-level study.

The method is documentary and analytical rather than survey-based. Four categories of source have been used: (i) the two preceding cMahanadi reports and their underlying departmental

datasets; (ii) official publications, parliamentary answers, Cabinet decisions, Finance Commission reports, tribunal and NGT orders, and statutory instruments; (iii) reports of multilateral and bilateral development institutions; and (iv) peer-reviewed literature and documented civil-society research on the basin. Spatial delineation uses the CWC basin and sub-basin boundaries and the State Water Resources Department sub-sub-basin layer held by cMahanadi.

Two conventions have been applied throughout. First, every quantitative claim carries a source reference, and figures that are derived from source data rather than reported directly are labelled as derived with the derivation shown. Second, no figure has been estimated to fill a gap. Where the required number could not be verified, the gap is stated explicitly and listed in Section 1.6 as a data requirement.

1.5 Structure of the report

Table 2 Structure and principal outputs of this report

Chapter	Question it answers	Principal output
1. Key Stakeholders	Who acts on the basin, with what mandate, influence and interest?	Seven-tier stakeholder inventory; influence-interest matrix; conflict map
2. Schemes and Convergence	Through which instruments do public money reach the basin, and where do they overlap?	Verified scheme inventory with outlays; four-axis convergence architecture; worked combinations
3. Economics and Valuation	What is the basin worth, what does degradation cost, and what do remedies cost?	TEV framework; damage and intervention unit costs; four illustrative CBAs with sensitivity analysis
4. Funding Models	How can interventions be paid for?	Seven models assessed on six criteria; suitability matrix; proposed basin financing architecture
5. Governance	Who is accountable for what, and by when?	Legal and institutional map; RACI matrix by function; phased timeline with indicators
6. Recommendations	What should be done, in what order?	Cross-cutting recommendations; three-phase institutional roadmap with milestones and risks

1.6 Data gaps and limitations

The following limitations should be read alongside the findings. They are stated here rather than in a concluding section because they condition the interpretation of every subsequent chapter.

- Basin-boundary versus administrative-boundary mismatch. Almost all fiscal, scheme and economic data in India are compiled by district and State, not by basin or sub-basin. Scheme outlays reported in this chapter and in Chapter 3 are therefore national or State totals, and their basin-attributable share cannot be computed without district-to-sub-basin apportionment that the source data do not support. Every such figure should be read as an indication of the scale of the instrument, not as expenditure in the basin.

- Absence of basin-level scheme expenditure accounting. No agency currently reports scheme expenditure against a basin geography. This is itself a principal finding and a principal recommendation, but it means the report cannot state what is actually spent in the Mahanadi Basin annually across all instruments.
- Water accounting gaps. Actual industrial water use, as distinct from allocated volumes, is not systematically metered or published. Allocation figures therefore overstate use to an unknown degree; a point made explicitly in the basin water-allocation literature [11].
- Valuation transferability. Ecosystem service valuations used in Chapter 4 are drawn from studies conducted at other sites or at State scale. Benefit transfer of this kind carries well-documented error, and the resulting figures are presented as order-of-magnitude indications, not as basin valuations.
- Illustrative rather than appraised CBAs. The cost-benefit analyses in Section 4.7 are calibrated on published unit rates and are intended to demonstrate method and establish orders of magnitude. They are not substitutes for project appraisal.
- Currency of scheme data. Scheme outlays, periods and guidelines change. Every entry in Chapter 3 carries the date of the source, and the inventory should be refreshed before use in any financing proposal.

A consolidated list of the specific datasets required to close these gaps, and the agencies that hold them, is given in Annexure A.

2. Key Stakeholders

2.1 Why stakeholder mapping matters in this basin

Stakeholder mapping is often treated as a preliminary courtesy in basin planning - a list of names appended to a technical document. In the Mahanadi the exercise carries greater analytical weight, for a specific reason. The basin's principal governance problem is not that stakeholders are unidentified, but that the mandates of identified stakeholders overlap without hierarchy. Several agencies hold partial authority over the same outcome; none holds sufficient authority to deliver it; and no forum exists at basin scale in which their competing claims can be resolved other than by escalation to a tribunal or a court.

The mapping presented here is therefore organised to expose three things: the mandate each actor holds and the statute or executive order from which it derives; the influence each actor exercises over basin outcomes in practice; and the interest each actor has in river condition specifically, as distinct from its own sectoral objective. Where mandate, influence and interest are misaligned, the mapping predicts where basin interventions will stall.

2.2 Classification framework

Stakeholders are classified along two dimensions. The first is tier, reflecting the level at which the actor operates and the source of its authority. The second is functional domain, reflecting the aspect of the basin the actor acts upon. An actor may occupy several functional domains - a State water resources department is simultaneously an allocator, an infrastructure owner and a

regulator - and it is precisely this multiplicity that produces the internal conflicts of interest examined in Chapter 6.

Table 3 Seven-tier stakeholder classification for the Mahanadi River Basin

Tier	Basis of authority	Illustrative actors	Characteristic role
T1 - Union	Union List Entry 56; central schemes; national regulators	MoJS/DoWR-RD&GR, NRCD, CWC, CGWB, MoEFCC, CPCB, MoHUA, MoRD, MoA&FW, Ministry of Coal, Ministry of Mines, Ministry of Power	Finance, standards, inter-State regulation, clearance
T2 - State	State List Entry 17; State legislation; State budgets	WRD, PHED/PR&DW, UAD/H&UDD, SPCBs, Forest & Environment, Agriculture, Revenue & DM, Mineral Resources, Energy departments of both States	Allocation, construction, operation, State-level regulation
T3 - Basin and project	ISRWD Act; NGT orders; project statutes	Mahanadi Water Disputes Tribunal, River Rejuvenation Committees, Hirakud reservoir regulation arrangements, Chilika Development Authority, OWSSB, WATCO	Adjudication, reservoir operation, basin-scale coordination
T4 - Local government	73rd and 74th Constitutional Amendments; State municipal and panchayat Acts	Municipal corporations, municipalities, Nagar Panchayats, Zilla Parishads, Panchayat Samitis, Gram Panchayats	Service delivery, local planning, own-source revenue
T5 - Community institutions	Pani Panchayat Act; FRA 2006; PESA; cooperative and SHG statutes	Pani Panchayats and WUAs, FRA gram sabhas, fisher cooperatives, SHG federations (Mission Shakti, Bihan), forest protection committees	Last-mile management, O&M, monitoring, local rule-making
T6 - Private sector	Environmental clearance, consent to operate, water licences, CSR obligation	Thermal power generators, integrated steel and aluminium producers, cement plants, coal and bauxite mining operations, sand mining lessees, EPC and O&M concessionaires	Major abstractor and discharger; potential financier and operator
T7 - Knowledge, finance and civil society	Institutional charter; loan and grant agreements	cMahanadi, NIT Raipur, NIT Rourkela, cGanga/IIT Kanpur, World Bank, JICA, ADB, AIIB, NABARD, research and advocacy organisations	Evidence, appraisal, concessional finance, advocacy, accountability

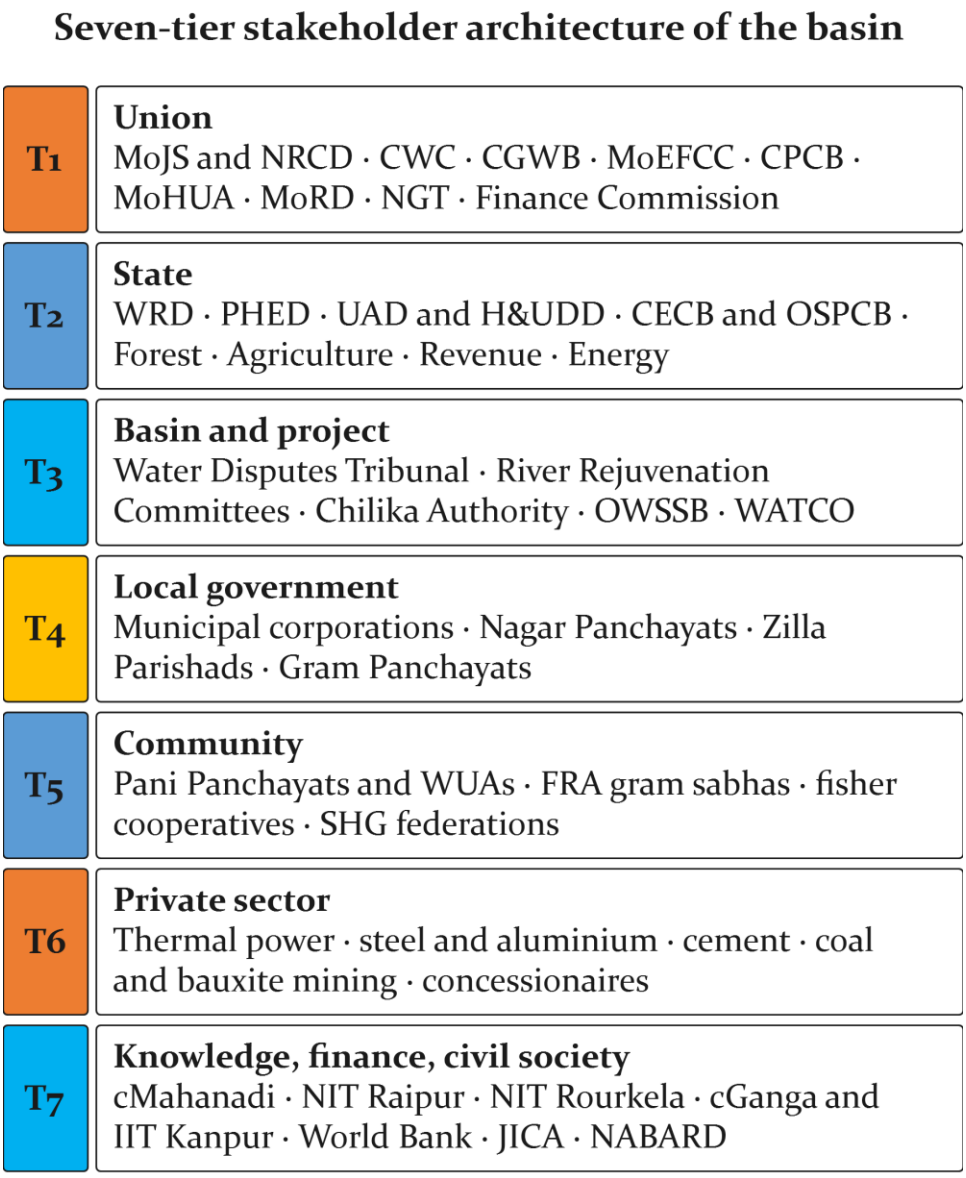


Figure 2 Seven-tier stakeholder architecture of the Mahanadi River Basin

2.3 Tier 1: Union institutions

Union institutions do not allocate Mahanadi water - that power rests with the States - but they determine the fiscal and regulatory envelope within which State allocation occurs. Their leverage is exercised through four channels: scheme finance and its conditionalities; environmental clearance and consent regimes; technical standards and data; and, in the specific case of inter-State disputes, the constitution of adjudicatory machinery under Article 262 and the Inter-State River Water Disputes Act, 1956.

Two observations follow from this table. First, no Union institution has river condition in the Mahanadi as its primary objective except NRCD, and NRCD commands the smallest resource envelope among the ministries listed - a point quantified in Chapter 3. Second, the institutions with the largest financial instruments relevant to the basin (MoHUA, DDWS, MoRD, Ministry

of Mines through DMF) pursue objectives that are strongly complementary to river restoration but are neither measured nor rewarded against it. Aligning measurement, rather than creating new money, is therefore the higher-return intervention at this tier.

Table 4 Tier 1 - Union institutions and their instruments relevant to the Mahanadi Basin

Institution	Principal mandate relevant to MRB	Primary instrument
Ministry of Jal Shakti - DoWR, RD & GR	National water policy; inter-State river regulation; irrigation and groundwater missions; constitution of tribunals	PMKSY; Atal Bhujal Yojana; ISRWD Act machinery; National Water Policy
National River Conservation Directorate (NRCD)	Pollution abatement in identified polluted stretches outside the Ganga basin; financial and technical assistance to States on a cost-sharing basis	National River Conservation Plan (NRCP)
Central Water Commission (CWC)	Basin delineation, hydrological observation, flood forecasting, dam safety, water-resource assessment	Basin reports; National Register of Large Dams; India-WRIS
Central Ground Water Board (CGWB)	Groundwater resource assessment and categorisation; aquifer mapping; regulation guidance	Dynamic Ground Water Resources assessment; NAQUIM
Ministry of Environment, Forest and Climate Change	Environmental and forest clearance for projects; compensatory afforestation; wetland rules	EIA Notification; Forest (Conservation) Act; CAMPA; Wetlands (Conservation and Management) Rules
Central Pollution Control Board (CPCB)	Identification of polluted river stretches; effluent and water-quality standards; direction to SPCBs	Water (Prevention and Control of Pollution) Act, 1974; polluted stretch prioritisation
Ministry of Housing and Urban Affairs	Urban water supply, sewerage, septage and solid waste; urban reform and municipal finance	AMRUT 2.0; SBM-Urban 2.0; Smart Cities Mission; municipal bond incentive
Ministry of Jal Shakti - DDWS	Rural drinking water and rural sanitation	Jal Jeevan Mission; SBM-Grameen
Ministry of Rural Development	Rural employment and natural-resource-management assets; watershed works	MGNREGA; Watershed Development Component of PMKSY
Ministry of Agriculture and Farmers' Welfare	Irrigation efficiency, crop planning, soil health, agricultural water productivity	PMKSY–Per Drop More Crop; crop diversification programmes
Ministry of Mines / Ministry of Coal	Mineral concessions; District Mineral Foundations; mine-water and overburden management	MMDR Act; DMF and PMKKKY
Ministry of Power / CEA	Thermal and hydro capacity planning; specific water consumption norms for thermal plants	Tariff and capacity planning; environmental norms for thermal power
National Green Tribunal	Adjudication of environmental compliance; environmental compensation; supervision of State action plans	NGT Act, 2010; O.A. 606/2018 and related proceedings
Finance Commission	Devolution and local body grants, including tied grants for water and sanitation	Constitutional recommendation under Article 280

2.4 Tier 2: State institutions

The two basin States have broadly parallel departmental architectures with significant differences in institutional maturity and in the degree to which functions have been corporatised. Odisha has moved further toward specialised delivery entities - notably OWSSB and WATCO for urban water and sewerage - and has a longer legislative history of participatory irrigation management through the Odisha Pani Panchayat Act, 2002. Chhattisgarh's water governance continues to rely substantially on legal instruments inherited from undivided Madhya Pradesh, a fragmentation noted in the Infrastructure and Planning Report [21].

Table 5 Tier 2 - Parallel State departmental architecture across the two basin States

Function	Chhattisgarh	Odisha
Surface water resources, irrigation, dams	Water Resources Department	Department of Water Resources (converted from Irrigation Department in the 1990s) [11]
Rural drinking water and sanitation	Public Health Engineering Department	Panchayati Raj and Drinking Water Department
Urban water supply, sewerage, septage	Urban Administration and Development Department; SUDA	Housing and Urban Development Department; OWSSB; WATCO
Pollution control and consent management	Chhattisgarh Environment Conservation Board (CECB)	Odisha State Pollution Control Board (OSPCB)
Forests, catchment, compensatory afforestation	Forest Department; State CAMPA	Forest, Environment and Climate Change Department; State CAMPA
Agriculture and irrigation efficiency	Directorate of Agriculture; Horticulture	Directorate of Agriculture and Food Production
Land records and revenue classification	Revenue and Disaster Management Department; Commissioner Land Records	Revenue and Disaster Management Department; Directorate of Economics and Statistics
Mining, minerals, DMF administration	Mineral Resources Department; District Mineral Foundations	Steel and Mines Department; District Mineral Foundations
Power and thermal generation	Energy Department; CSPDCL and generating companies	Energy Department; OHPC and generating companies
Fisheries and aquatic livelihoods	Fisheries Department	Fisheries and Animal Resources Development Department
Panchayati Raj and rural local government	Panchayat and Rural Development Department	Panchayati Raj and Drinking Water Department

The practical significance of this table is that every basin-scale intervention requires a matched pair of counterparts across two State governments whose departmental boundaries do not align perfectly and whose planning calendars are independent. A sewage-abatement programme on the main stem, for example, engages UAD and CECB in Chhattisgarh and H&UDD, OWSSB and OSPCB in Odisha, with no standing forum in which the five can sequence their work. This is the coordination cost that a basin institution is designed to eliminate, and it is the principal argument of Chapter 7.

2.5 Tier 3: Basin and project-level bodies

Bodies at this tier come closest to operating at basin scale, but each is constrained either in mandate or in geography.

- Mahanadi Water Disputes Tribunal (MWDT). Constituted under the Inter-State River Water Disputes Act, 1956 to adjudicate the dispute between Odisha and Chhattisgarh over sharing of Mahanadi waters, with particular reference to non-monsoon availability. Following the resignation of its previous chair, the Tribunal is presided over by Justice Bela M. Trivedi. Its term has been extended and it has directed the two States to reach a mutually acceptable settlement, failing which it will deliver a binding award [15]. The MWDT is the only body with authority over both States on the allocation question, but its mandate is adjudicatory and finite - it resolves a dispute; it does not manage a basin.
- River Rejuvenation Committees (RRCs). Constituted pursuant to NGT directions to prepare and monitor action plans for rejuvenation of polluted river stretches. In Odisha the RRC operates under the overall supervision and coordination of the Additional Chief Secretary, Forest and Environment Department, and action plans for all 19 identified polluted stretches were prepared and submitted to CPCB [18]. RRCs are the closest existing analogue to a basin coordination body, but they are State-bounded and stretch-focused rather than basin-wide.
- Special Environment Surveillance Task Force. Constituted at district level by the Forest and Environment Department in Odisha to prevent illegal mining in the beds of polluted river stretches [18]. A narrowly-scoped but operationally significant enforcement instrument.
- Hirakud reservoir regulation arrangements. Hirakud is the pivotal control structure of the basin, with a reservoir capacity of about 5,896 MCM and an installed hydropower capacity of 347.5 MW across Powerhouse I at Burla and Powerhouse II at Chiplima [21]. Its operating rules determine the distribution of water among irrigation, power, industrial supply and flood moderation, and are therefore the single most consequential set of operational decisions in the basin.
- Chilika Development Authority. Manages the Chilika lagoon, the basin's terminal receiving water body through the Daya and associated sub-basin, and a Ramsar site supporting large fisher populations. Its mandate is ecosystem-specific but it is a necessary party to any delta or estuarine intervention.
- OWSSB and WATCO (Odisha). Delivery entities for urban water supply and sewerage, and the operational vehicles through which the Sujal - Drink from Tap Mission and associated sewerage works are implemented [17].

2.6 Tier 4: Urban and rural local government

Local bodies are where river outcomes are actually produced or lost. Sewage that reaches a river does so through a municipal drain; solid waste that reaches a floodplain does so through a municipal collection failure; and the catchment works that determine lean-season flow are executed through panchayats. Yet the Infrastructure and Planning Report documents

systematic weakness at exactly this tier: Service Level Benchmarking across 43 cities and towns in Chhattisgarh found water supply typically available for only two to four hours, revenue from water sales insufficient to cover operational cost, absence of metering for commercial and high-volume users, high non-revenue water, and shortages of managerial and technical staff [21].

The fiscal dimension of this weakness is stark. The same report records that smaller towns received only ₹498 per capita against ₹4,030 for rural areas under the relevant allocation arrangements, and that a large urban poor population - 5.45 lakh BPL families including 2.5 lakh in slums - concentrates service demand precisely where municipal capacity is weakest [21]. A basin strategy that assigns implementation responsibility to ULBs without simultaneously addressing their revenue base and staffing is assigning work to the weakest link in the chain. This conclusion drives the emphasis on municipal own-source revenue and creditworthiness in Chapter 5.

2.7 Tier 5: Community institutions

Community institutions in the basin are more developed than is often assumed, and represent the principal underused asset in basin governance.

- Pani Panchayats and Water Users' Associations. The Odisha Pani Panchayat Act, 2002, amended in 2008 to include fisherfolk, provides for participatory irrigation management with transfer of tertiary networks - minors and sub-minors - to registered Pani Panchayats, which collect water rates, distribute canal water and maintain lower-level canals, while the Department of Water Resources retains O&M of the reservoir, spillways, sluices and primary and secondary networks. The programme covers approximately 18.25 lakh hectares of major, medium and minor irrigation command across all 30 districts of Odisha [11]. Its origins lie in the Farmers Organisation and Turnover programme under the World Bank-funded Orissa Water Resources Consolidation Project, and implementation gaps between the statutory design and field practice are well documented [11, 21].
- Forest Rights Act gram sabhas. In the forested sub-basins - Mand, Hasdeo, upper Tel and parts of Jonk and Pairi - gram sabhas hold statutory authority over community forest resources under the Forest Rights Act, 2006. Since catchment condition in these sub-basins governs lean-season flow and sediment yield for the whole basin, these bodies are hydrologically consequential far beyond their immediate area.
- Self-help group federations. Both States have built substantial SHG delivery capacity in the water and sanitation chain. In Odisha, Mission Shakti SHGs and transgender groups are engaged across the faecal sludge and septage management value chain, with 109 septage treatment plants managed by women and transgender groups, and the associated SUJOG service platform reporting over 200 crore rupees in revenue across 30 districts [18]. The Jalasathi programme appoints women SHG members as the community interface with WATCO for metering, billing and grievance redress [17]. In Chhattisgarh, over 9,000 women working as 'Safai Didis' have been integrated into municipal solid waste collection and processing [21].

- Fisher cooperatives. Concentrated in the Hirakud reservoir, the lower main stem, the delta and Chilika. Fisher livelihoods are directly and immediately sensitive to flow regime, water quality and lagoon salinity, giving this group the highest interest-to-influence ratio of any stakeholder in the basin.
- Forest protection and eco-development committees. Village-level bodies engaged in afforestation, riverbank plantation and bamboo regeneration works, including under the Ecosystem Services Improvement Project supported by the World Bank [21].

2.8 Tier 6: Private sector and industry

The Mahanadi Basin is among the most industrially significant river basins in India, and industry is simultaneously the basin's largest incremental water claimant, a significant discharger, and a potential source of finance and operating capability.

The scale of industrial claim is documented in the basin water-allocation literature. Using a database of environmental clearances, total water allocated to large industries in the basin has been estimated at about 1,130 MCM in Chhattisgarh and 944 MCM in Odisha, or 2,074 MCM in aggregate - approximately 4 per cent of the basin's utilisable surface water. Of this, about 1,661 MCM, or 80 per cent, is allocated to thermal power generation alone, an increase from 364 MCM in 2007, against an estimated 55 GW of thermal capacity of which roughly 23 GW was commissioned as of 2016; a further 413 MCM is allocated to iron and steel, with a smaller share to aluminium [11]. The Infrastructure and Planning Report independently records an estimated 1,258.16 MCM allocated annually for industries in Chhattisgarh, supplying over 45 power plants [21].

Three features of these figures matter for stakeholder analysis. First, allocation substantially exceeds actual use, because clearances are granted against planned rather than commissioned capacity; the resulting overhang is a claim on future water that has already been legally created. Second, the concentration in thermal power means that a small number of corporate actors hold a large share of the industrial claim, which makes negotiated efficiency improvement tractable in a way that diffuse agricultural demand is not. Third, industrial allocations are made against a public water source at administered rates, while the downstream cost of those allocations falls on unrepresented users - the classic configuration in which a basin-level economic instrument is warranted.

The concentration of industrial pressure in this basin is documented in the Central Pollution Control Board's Comprehensive Environmental Pollution Index. Under the original 2009 assessment, which identified 43 critically polluted areas nationally with a CEPI above 70, four of them lay in the Mahanadi Basin - Korba, Angul-Talcher, Ib Valley and Jharsuguda - with Raipur and Paradeep additionally classified as severely polluted in the 60 to 70 band [33]. CPCB revised the CEPI methodology in 2016 and published a re-assessment of 100 clusters monitored during 2018. The table below sets both rounds side by side.

Table 6 Comprehensive Environmental Pollution Index scores for Mahanadi Basin industrial clusters

Cluster	State	CEPI 2009	2009 class	CEPI 2018 (revised method)	Air / Water / Land sub-indices, 2018
Korba	Chhattisgarh	83.00	Critically polluted	57.57	43.75 / 17.75 / 54.00
Angul-Talcher	Odisha	82.09	Critically polluted	46.43	44.75 / 13.25 / 23.00
Ib Valley	Odisha	74.00	Critically polluted	66.35	48.75 / 59.00 / 36.75
Jharsuguda	Odisha	73.34	Critically polluted	37.20	36.00 / 21.50 / 8.75
Paradeep	Odisha	69.26	Severely polluted	60.61	43.00 / 57.50 / 17.00
Raipur	Chhattisgarh	65.45	Severely polluted	70.77	67.00 / 45.75 / 25.00
Bhilai-Durg	Chhattisgarh	-	-	46.69	43.00 / 32.75 / 19.75

Source: CPCB CEPI assessments as reproduced in National Green Tribunal proceedings [33]. The 2009 and 2018 columns are not directly comparable: CPCB revised the CEPI formula in 2016, and the 2018 round applied the revised method to 100 clusters. Sub-indices are Air, Surface Water, and Soil and Ground Water.

Two points follow for basin management. First, the apparent improvement between the two rounds should be read with caution, because the methodology changed; what can be said is that under the revised method no Mahanadi cluster now exceeds the critical threshold of 70 except Raipur, at 70.77. Second, and more useful operationally, the water sub-index identifies where the river-condition problem actually sits. Ib Valley records a surface water sub-index of 59.00 and Paradeep 57.50 - by some margin the highest in the basin - while Angul-Talcher, historically the most notorious cluster, records 13.25. For a report concerned with river condition rather than with air quality, this reorders the priorities: Ib Valley is the basin's principal industrial water-pollution cluster, notwithstanding that its aggregate CEPI is lower than Korba's. The Ib sub-basin is also, as Section 3.2.2 notes, among the districts holding the largest District Mineral Foundation balances.

Beyond abstraction, the private sector enters the basin as EPC contractor, HAM concessionaire, O&M operator, CSR funder and, through the District Mineral Foundation levy, as an involuntary contributor to area development finance. Chapter 5 treats each of these roles as a distinct financing channel with distinct governance requirements.

2.9 Tier 7: Knowledge institutions, development finance and civil society

This tier supplies the basin with three things it cannot generate internally: independent evidence, concessional capital, and accountability pressure.

- Knowledge institutions. cMahanadi, jointly hosted by NIT Raipur and NIT Rourkela under the supervision of cGanga at IIT Kanpur, functions as the knowledge wing of

NRCD for this basin. Its comparative advantage is that it is the only entity producing basin-scale synthesis across land, infrastructure, institutions and economics - the function that this report series performs.

- Development finance institutions. The World Bank has an established position in the basin through the Odisha Integrated Irrigation Project for Climate Resilient Agriculture, a $165 million loan agreement signed in 2019 to intensify and diversify agricultural production, enhance climate resilience and improve water productivity, benefiting about 125,000 smallholder households across 15 districts managing some 128,000 ha [12]; and through the Ecosystem Services Improvement Project supporting forest cover, carbon sequestration and eco-friendly livelihoods [21]. JICA has supported urban sanitation in the basin, including works associated with the Odisha Integrated Sanitation Improvement Programme referenced in Cuttack [21]. NABARD finances irrigation and rural infrastructure through the Rural Infrastructure Development Fund.

Table 7 Influence–interest positioning of Mahanadi Basin stakeholders

Quadrant	Characterisation	Actors	Engagement strategy
High influence, high interest	Natural leaders of basin reform; few in number	State Water Resources Departments; NRCD; MWDT; River Rejuvenation Committees; OWSSB/WATCO; Chilika Development Authority	Manage closely; vest formal basin roles here; make them accountable for basin indicators
High influence, low interest	Can block or enable, but river condition is not their objective function	MoHUA, DDWS and MoRD scheme owners; State Finance and Industries departments; thermal power, steel and aluminium majors; mining lessees; DMF trusts	Keep satisfied and realign incentives: tie a share of scheme or DMF performance to basin indicators; negotiate efficiency and reuse commitments
Low influence, high interest	Bear the cost of basin degradation but cannot alter it; the basin's equity problem	Tail-end farmers; fisher cooperatives in Hirakud, the lower main stem and Chilika; delta communities facing salinity; forest-dwelling and Scheduled Tribe households; urban poor in slum settlements	Empower structurally: statutory representation on basin bodies, functional Pani Panchayats and FRA gram sabhas, transparent grievance channels, and standing in allocation decisions
Low influence, low interest	Peripheral to basin decisions but affected by outcomes	General urban consumers; downstream commercial establishments; tourism operators; non-basin residents of the two States	Monitor and inform; mobilise through disclosure of water quality and service performance

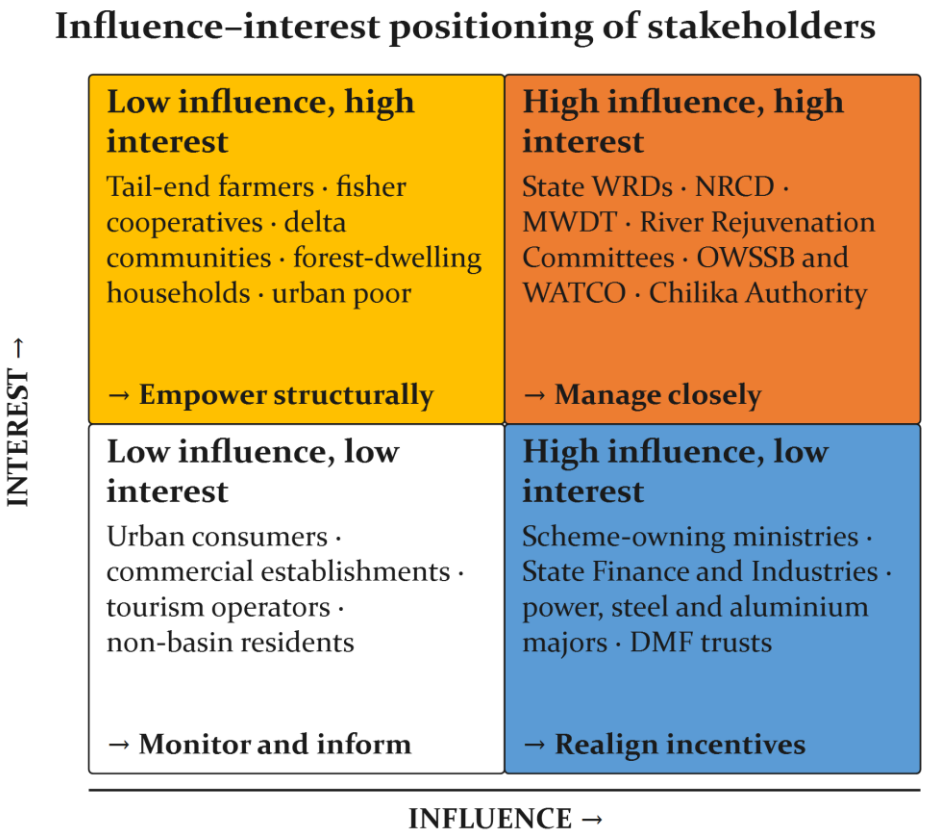
- Civil society and research organisations. Independent research on Mahanadi water allocation, notably the basin-scale allocation study drawn on throughout this report [11], has produced datasets that no official source currently publishes - in particular the

reconciliation of industrial allocations from environmental clearance records. Advocacy organisations working on drinking water access, sanitation and tribal rights supply field evidence that complements departmental reporting; the Infrastructure and Planning Report cites, for example, a 2023 assessment finding that 26.97 per cent of Anganwadi centres in Odisha lacked drinking water facilities while a further 57.62 per cent had non-functional systems [21].

Combining mandate, resource control and practical leverage produce the influence-interest positioning summarised below. Influence is assessed as the actor's effective capacity to change basin outcomes; interest is assessed as the sensitivity of the actor's own welfare or objectives to river condition specifically.

The distribution above is the analytical heart of this chapter. The basin's most interested stakeholders are its least influential ones, and its most influential stakeholders are the least interested in river condition as such. No procedural reform to consultation practice corrects this; it is a structural feature of how authority and cost are distributed in the basin. Two categories of remedy follow, and both are pursued in later chapters: give the low-influence, high-interest group formal standing and resources (Chapter 6), and give the high-influence, low-interest group a financial reason to care (Chapters 4 and 5).

2.10 Influence–interest analysis



The most interested stakeholders are the least influential; the most influential are the least interested in river condition.

Figure 3 Influence–interest positioning of Mahanadi Basin stakeholders

2.11 Conflict mapping

Five conflict axes recur in the basin. Each is a predictable consequence of the stakeholder configuration described above, and each requires a different resolution instrument.

Table 8 Conflict axes in the Mahanadi Basin and matched resolution instruments

Axis	Parties	Substance of the conflict	Resolution instrument
Inter-State	Chhattisgarh (upstream) and Odisha (downstream)	Sharing of Mahanadi waters, particularly non-monsoon flow; upstream barrages, diversion weirs and intra-State links including projects to which Odisha has objected [21]	MWDT award or negotiated settlement [15]; thereafter a standing basin institution to implement and adapt the allocation
Inter-sectoral	Irrigated agriculture versus industry, principally thermal power	Reallocation of stored and run-of-river water to industrial use; documented farmer opposition to industrial allocations from basin structures [11]	Transparent allocation rules with published priority ordering; volumetric measurement; economic instruments reflecting scarcity value
Spatial (upstream–downstream)	Head-reach and tail-end users within command areas	Tail-end deprivation in canal commands; head-reach over-abstraction; documented as a persistent feature of basin irrigation systems [11]	Functional Pani Panchayats with real authority; rotational supply (warabandi-type) rules; measurement at distributary heads
Vertical (State–local)	State departments and ULBs/PRIs	Responsibility for service outcomes devolved to local bodies without matching revenue, staff or technical capacity [21]	Finance Commission grant design; own-source revenue reform; ring-fenced O&M provision in project sanction
Temporal	Present claimants and future users; present abstraction and future assimilative capacity	Allocations granted against uncommissioned capacity create claims on future water; deferred O&M creates future liabilities; groundwater over-extraction transfers cost forward	Sunset and review clauses on allocations; mandatory O&M escrow; groundwater regulation; environmental flow provision

2.12 Implications for the rest of this report

Three findings from this chapter carry forward. First, basin outcomes are produced by actors whose objectives are not river condition, which means the design problem is one of incentive alignment rather than of exhortation - hence Chapter 3's focus on convergence and Chapter 5's

on financing instruments. Second, the actors bearing the cost of degradation lack standing in the decisions that cause it, which is an equity failure with an institutional remedy - hence Chapter 6's allocation of roles and Chapter 7's roadmap. Third, no existing body operates at basin scale with a continuing management mandate; the MWDT adjudicates and will conclude, RRCs are State-bounded, and Union institutions finance without managing. That vacancy is the specific gap the institutional roadmap in Chapter 7 is designed to fill.3. Schemes and its Convergence

3.1 Approach to scheme mapping

This chapter compiles the public financing instruments that bear on Mahanadi Basin outcomes and then examines where they can be made to reinforce one another. Three conventions govern the compilation.

Outlays are national or State totals, not basin expenditure. No scheme in India reports expenditure against a river basin geography. The outlays in the tables below therefore indicate the scale of each instrument, not money spent in the Mahanadi. Establishing basin-attributable expenditure requires district-to-sub-basin apportionment of scheme accounts, which is recommended in Chapter 7 as a Phase I action precisely because it cannot presently be done.

Only verified figures appear. Each entry carries its source and the date to which the figure relates. Where an outlay could not be verified from an official source it is marked accordingly rather than estimated.

Relevance is assessed functionally. A scheme is included if its outputs alter one of five basin variables: water quantity abstracted, water quality discharged, catchment condition, water-use efficiency, or the institutional and financial capacity to manage any of these.

3.2 Central schemes

The table below sets out the principal central instruments. The column headed "Basin relevance" states the causal pathway by which the scheme affects river condition - which is what makes convergence analysis possible in Section 3.6.

Table 9 Central schemes and instruments relevant to the Mahanadi River Basin, with verified outlays

Scheme / instrument	Ministry	Period	Verified outlay	Basin relevance
National River Conservation Plan (NRCP)	MoJS - NRCD	Ongoing CSS	₹8,970.51 crore sanctioned; 58 rivers, 100 towns, 17 States; 3,019 MLD capacity created (as reported 23 March 2026) [2]	Direct: interception and diversion, sewerage, STPs, low-cost sanitation, ghat and riverfront works in identified polluted stretches
Jal Jeevan Mission (Rural) / JJM 2.0	MoJS - DDWS	2019 to Dec 2028	Initial ₹3.60 lakh crore (Centre ₹2.08 lakh crore, States ₹1.52 lakh crore);	Indirect but large: shifts rural demand from contaminated

		(extended)	enhanced in 2025 to ₹8.69 lakh crore total with central assistance of ₹3.59 lakh crore [5]	and over-drawn sources; source sustainability works alter recharge
AMRUT 2.0	MoHUA	2021-22 to 2025-26	₹2,99,000 crore [4]	Direct: urban water supply, sewerage, septage, water-body rejuvenation and recycled-water reuse in basin towns
Swachh Bharat Mission - Urban 2.0	MoHUA	2021-22 to 2025-26	₹1,41,600 crore [4]	Direct: used-water and faecal sludge management, legacy waste remediation - the two largest sources of municipal load on basin rivers
Swachh Bharat Mission - Grameen Phase II	MoJS - DDWS	2020-21 to 2024-25	₹1,40,881 crore, of which ₹52,497 crore from the DDWS budget and the balance dovetailed from Fifteenth Finance Commission grants, MGNREGS and revenue models [23]	Direct: ODF sustainability plus solid and liquid waste management, greywater and faecal sludge management in basin villages
Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)	MoJS / MoA&FW / MoRD	2021-26	₹93,068 crore, including central support of ₹37,454 crore to States and ₹20,434.56 crore of debt servicing [24]	Direct: Accelerated Irrigation Benefit Programme works, Har Khet Ko Pani, Watershed Development Component, Per Drop More Crop micro-irrigation
MGNREGA	MoRD	Statutory, annual	Annual budgetary allocation (verify current year before use)	Direct on catchment: water conservation and harvesting, renovation of traditional water bodies, afforestation, drainage-line treatment - executed at gram panchayat scale
Smart Cities Mission	MoHUA	Concluded phase	Bhubaneswar: Area-Based Development approximately ₹4,095 crore and Pan-City	Mixed: waterfront development, storm-water and sewerage components in basin cities; heavily skewed

			approximately ₹442 crore [21]	to area-based rather than pan-city investment
Fifteenth Finance Commission local body grants	Finance Commission / MoF	2021-22 to 2025-26	₹1,42,084 crore tied grant to rural local bodies for water and sanitation; ₹1,21,055 crore for urban local bodies [7]	Direct and untied at the point of use: the largest predictable flow available to local bodies for water and sanitation O&M and small works
Sixteenth Finance Commission local body grants	Finance Commission / MoF	2026-27 to 2030-31	₹9.47 lakh crore total grants; ₹4.4 lakh crore rural and ₹3.6 lakh crore urban local bodies, split 80 per cent basic and 20 per cent performance; sector-specific and state-specific grants discontinued [6]	Direct: the principal predictable local-body flow for the coming cycle, with a materially larger urban share and a performance component that can be linked to service outcomes
District Mineral Foundation / PMKKKY	Ministry of Mines; State DMF trusts	Ongoing since 2015	Cumulative national collection approximately ₹1.02 lakh crore to November 2024; Odisha ₹13,728 crore and Chhattisgarh ₹7,151 crore; at least 70 per cent earmarked to high-priority sectors including drinking water, environment and sanitation [8]	Direct and geographically precise: funds are held in the mining districts that dominate the Ib, Hasdeo, Mand and upper Tel sub-basins, which are also the basin's principal industrial pollution and land-degradation zones
Compensatory Afforestation Fund (CAMPA)	MoEFCC; National and State CAMPA	CAF Act 2016; Rules 2018	One-time transfer of ₹47,436 crore to 27 States/UTs in August 2019, of which Odisha received ₹5,933.98 crore and Chhattisgarh ₹5,792 crore - the two largest State shares in the country [27]. Chhattisgarh held ₹2,596.26 crore unspent as on 01.04.2023 against an APO of ₹737.08 crore for 2024-25 [26]. Nationally, APOs of ₹50,264 crore were approved between 2018-19 and 2024-25, of which	Direct on catchment: compensatory afforestation, catchment area treatment plan, soil and moisture conservation, and wildlife and habitat works in the forested sub-basins

			₹36,745 crore (73 per cent) was released and ₹26,276 crore (52 per cent) utilised to December 2024 [29]	
Atal Bhujal Yojana	MoJS - DoWR	2020-21 to 2024-25	₹6,000 crore, implemented in seven States: Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh [25]	Not applicable to this basin. Neither Chhattisgarh nor Odisha is a participating State - a material gap given documented groundwater stress in parts of the basin

Note: Outlays are national totals for the stated mission period unless otherwise specified. They are not, and should not be read as, expenditure within the Mahanadi River Basin. See Section 3.1.

3.2.1 The proportionality finding

Reading that table as a whole yields the single most consequential finding of this chapter. The instrument whose explicit purpose is river conservation - NRCP - carries a sanctioned outlay of ₹8,970.51 crore accumulated across 58 rivers, 100 towns and 17 States over the life of the programme [2]. The instruments whose purposes are adjacent to river condition - urban water and sanitation, rural drinking water, rural sanitation, irrigation, and mining-area development - carry outlays two orders of magnitude larger for their current cycles alone.

It follows that the marginal rupee available for river restoration in the Mahanadi is far more likely to come from AMRUT, SBM, JJM, the Finance Commission or a District Mineral Foundation than from NRCP. This is not a criticism of NRCP; it is a statement about where the money is. NRCP's comparative advantage lies in its mandate rather than its balance sheet - it is the only listed instrument whose objective function is river condition itself. The strategically correct use of NRCP in this basin is therefore not as the primary funder of works but as the agenda-setter, sequencer and quality assurer for far larger flows already arriving for adjacent purposes. Every subsequent recommendation in this chapter follows from that proposition.

A second, narrower finding is that Atal Bhujal Yojana, the country's principal participatory groundwater management scheme, does not operate in either basin State [25]. Given the documented groundwater dependence of the basin - over 80 per cent of rural supply in Odisha drawn from groundwater sources, near-exclusive groundwater dependence in the delta with users shifting to deeper aquifers as upper layers salinise, and 58.4 per cent of Chhattisgarh households relying on hand pumps [21] - the absence of a demand-side groundwater governance instrument is a structural gap. Either the extension of Atal Bhujal-type coverage to the basin, or the construction of an equivalent State instrument, is a first-order recommendation.

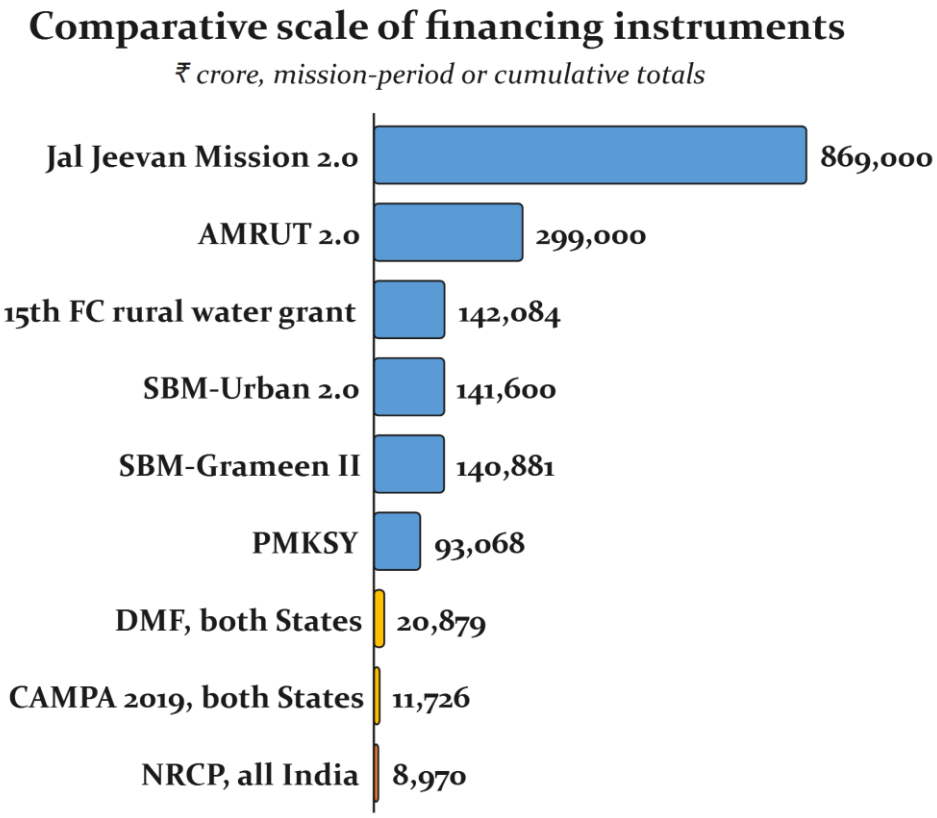


Figure 4 Comparative scale of financing instruments reaching the Mahanadi Basin

3.2.2 The extractive-industry funds: the basin's largest untapped resource

Two instruments in the central-scheme inventory share a characteristic that distinguishes them from every other entry: they are funded by levies on extractive industry, they are already collected and held, and they are earmarked to purposes that overlap substantially with basin restoration. Their combined scale in the two basin States is set out below, and it is the single most important financing fact in this report.

Table 10 Extractive-industry-derived funds available in the two Mahanadi basin States

Instrument	Odisha	Chhattisgarh	Combined	Earmarking
CAMPA - one-time transfer, August 2019	₹5,933.98 crore (largest State share nationally)	₹5,792 crore (second largest)	₹11,726 crore, about a quarter of the ₹47,436 crore transferred to 27 States/UTs [27]	Compensatory afforestation, catchment area treatment plan, soil and moisture conservation, wildlife habitat
CAMPA - unspent balance	Not separately verified; CAG records	₹2,596.26 crore as on 01.04.2023, against an APO	Substantial in both States	As above

held by the State	₹2,284.98 crore received during 2019-22, of which ₹210.54 crore was not utilised [28]	of ₹737.08 crore [26]		
District Mineral Foundation / PMKKKY	₹13,728 crore accumulated	₹7,151 crore accumulated	₹20,879 crore [8]	At least 70 per cent to high-priority sectors including drinking water, environment preservation and pollution control, and sanitation
Indicative combined magnitude	-	-	**On the order of ₹32,000 crore, against a national NRCP sanction of ₹8,970.51 crore since inception [2]**	**Environmental restoration, water, sanitation and area development in mining-affected districts**

Note: CAMPA transfer and DMF figures relate to different dates and are not additive in an accounting sense. The combined magnitude is indicative of order and is presented to establish scale, not as a balance-sheet total.

Three observations follow, and they should govern how basin financing is approached.

First, the geography is exactly right. Both instruments concentrate funds in mining and forest-diversion districts. In the Mahanadi these are the Ib, Hasdeo, Mand and upper Tel sub-basins - the basin's principal industrial pollution and land-degradation zones, and the catchments whose condition governs lean-season flow and sediment yield for the whole system. There is no other financing instrument in this chapter whose money is already located where the need is greatest.

Second, CAMPA already contains the right budget head. Catchment Area Treatment Plan is a named CAMPA activity, not an interpretation. Yet in Chhattisgarh, of the ₹2,596.26 crore held as on 1 April 2023, only ₹19.32 crore - about 0.7 per cent - sat in the Catchment Area Treatment Plan head, against ₹1,121.93 crore under compensatory afforestation and ₹583.63 crore of accumulated interest [26]. The constraint on catchment finance is not the size of the fund but the head it is parked in. Given the economics established in Chapter 4, re-weighting future Annual Plans of Operation toward catchment treatment is among the highest-return decisions available to either State Authority.

Third, absorption rather than availability is the binding constraint. Nationally, only 52 per cent of approved CAMPA plan value had been utilised by December 2024 [29]. In Odisha, the Comptroller and Auditor General found that of ₹2,284.98 crore received during 2019-22 the State

CAMPA failed to utilise ₹210.54 crore; that annual accounts had not been finalised since inception in 2009; that ₹56.82 crore was irregularly utilised on construction works and ₹248.06 crore diverted to another State scheme; and that the Monitoring and Evaluation wing undertook no monitoring or evaluation activity during the period [28]. Money is not the scarce input here. Plans, absorptive capacity and accounts are. This finding is carried into the funding-model assessment in Section 5.6 and into the governance gaps in Section 6.3.

3.3 Chhattisgarh State schemes and initiatives

Chhattisgarh's State-level interventions have concentrated on rural natural-resource management and on municipal solid waste, with strong results in the latter. The State was adjudged India's cleanest state in Swachh Survekshan 2020, having implemented door-to-door collection across all 166 urban local bodies with source segregation, processing approximately 1,650 tonnes of waste daily and integrating over 9,000 women as 'Safai Didis' into the system [21].

Table 11 Chhattisgarh State initiatives relevant to the Mahanadi Basin

Initiative	Department	Substance	Basin relevance
Suraji Gaon Yojana - Narva, Garuwa, Ghurwa, Bari (NGGB)	Panchayat and Rural Development; WRD; Forest	Integrated village-level programme: Narva (stream and drainage-line treatment), Garuwa (livestock and gauthans), Ghurwa (composting), Bari (homestead horticulture) [20]	High. The Narva component is the State's principal instrument for first-order stream and nala treatment, which is the intervention class with the strongest lean-season flow and sediment benefits in the upper basin
Narva Development Plan (groundwater augmentation works)	Forest Department; WRD	Over 25 lakh groundwater augmentation structures constructed in 2019-20 and 2020-21 at a cost of ₹370 crore, covering 7.04 lakh hectares across 1,995 drains; approximately 50 lakh person-days generated [21]	High and quantified. One of the few basin interventions with both a cost figure and an area figure, permitting the unit-cost analysis in Chapter 4
Solid waste management programme (ULB-wide)	Urban Administration and Development Department	100 per cent door-to-door collection across 166 ULBs; approximately 1,650 TPD processed at about 90 per cent processing rate in 2019 [21]	High. Reduces solid waste load reaching drains and floodplains; the residual 28.2 per cent of 3,871 TPD unprocessed remains the target gap [21]
Community sanitation under	Panchayat and Rural Development	Over 18,300 community sanitation activities planned under the Fifteenth Finance	High. Directly addresses the rural liquid and solid waste

Fifteenth Finance Commission grants		Commission cycle (2023-24); household incentive of ₹12,000 for toilet construction; FSTPs and plastic waste management units; over 67 per cent of villages under the ODF Plus model [21]	pathways into basin streams
Mission Jal Raksha	Panchayat and Rural Development	Water conservation and source sustainability campaign [21]	Moderate: recharge and conservation benefits, concentrated in rural catchments
Bhagirathi Nal-Jal Yojana	Urban Administration and Development Department	Piped water supply to approximately 2.5 lakh poor families in slum settlements across urban centres at no cost [21]	Moderate: reduces dependence on contaminated local sources; increases wastewater generation, which must be matched by treatment capacity
Kharun Riverfront development, Raipur	Urban Administration and Development Department; SUDA	Riverfront revitalisation in the State capital [21]	Mixed: aesthetic and recreational gains; ecological outcome depends entirely on whether upstream sewage interception precedes the frontage works

3.4 Odisha State schemes and initiatives

Odisha's State-level interventions have concentrated on urban water service quality and on decentralised faecal sludge and septage management, and have gone further than most Indian States in institutionalising community - specifically women's - delivery roles.

Table 12 Odisha State initiatives relevant to the Mahanadi Basin

Initiative	Department / entity	Substance	Basin relevance
Sujal - Drink from Tap Mission	H&UDD; WATCO; OWSSB	24×7 quality-assured piped supply in urban areas; approximately ₹790 crore spent on the initial phase, with extension to further cities at a reported cost of about ₹1,300 crore [17]	High. Reduces reliance on contaminated sources and, through metering and continuous supply, creates the billing base that municipal creditworthiness in Chapter 5 depends on

Jalasathi	H&UDD; WATCO; Mission Shakti	Women SHG members appointed as Jalasathis on an incentive-based partnership to act as the community interface with the utility for metering, billing and grievance redress [17]	High institutionally. Converts the low-influence, high-interest group identified in Chapter 2 into a paid, formal part of service delivery
Decentralised FSSM and septage management	H&UDD; ULBs; Mission Shakti SHGs and transgender groups	120 septage treatment plants of 2,087 KLD total capacity across 115 ULBs against 1,136 KLD generated; 109 plants managed by women and transgender groups; SUJOG online booking platform across all 30 districts with over 480,000 applications and more than ₹200 crore in revenue [18]	Very high. Demonstrates that decentralised treatment can be delivered at lower capital cost than conventional sewerage and can generate revenue - the most directly transferable model in the basin
Action plans for polluted river stretches	Forest and Environment Department; OSPCB; RRC	Action plans prepared for all 19 CPCB-identified polluted stretches and submitted to CPCB, addressing source control, catchment and basin management, controlled groundwater extraction, floodplain zoning and environmental flows [18]	High. Twelve of Odisha's nineteen polluted stretches lie in the Mahanadi basin [18], making these plans the operative pollution-abatement documents for the basin's Odisha reach
River Rejuvenation Committee and Special Environment Surveillance Task Force	Forest and Environment Department	RRC under the Additional Chief Secretary to prepare and monitor rejuvenation action plans; district task forces to prevent illegal riverbed mining in polluted stretches [18]	High. The nearest existing analogue to a basin coordination body, though State-bounded
Pani Panchayat programme	Department of Water Resources	Participatory irrigation management under the Odisha Pani Panchayat Act, 2002 (amended 2008 to include fisherfolk); tertiary network O&M and water-rate collection transferred to registered Pani Panchayats across approximately 18.25 lakh hectares of command in all 30 districts [11]	High. The basin's principal existing mechanism for demand-side irrigation management, though with documented gaps between statutory design and field practice [11, 21]
Mahanadi Waterfront Project, Cuttack	H&UDD; Cuttack Municipal Corporation	Riverfront transformation announced at a cost of ₹200 crore [21]	Mixed: as with Kharun, the ecological return depends on prior interception of

			the drains discharging to the reach
Ecosystem Services Improvement Project (ESIP)	Forest, Environment and Climate Change Department; World Bank	Forest cover enhancement, carbon sequestration and eco-friendly livelihood options for small and marginal farmers, including organic farming and agroforestry to reduce agricultural runoff [21]	High on catchment. Directly addresses the non-point-source pathway that treatment plants cannot reach
OIIPCRA	Department of Water Resources; World Bank	$165 million loan agreement signed 2019 to intensify and diversify production, enhance climate resilience and improve water productivity; about 125,000 smallholder households across 15 districts managing approximately 128,000 ha [12]	High. The basin's largest external-finance operation on the demand side of irrigation water

3.5 Comparative reading of the two State portfolios

The two State portfolios are strikingly complementary, and each State has demonstrated capability the other lacks. Chhattisgarh has the stronger rural catchment-treatment instrument in the Narva component of Suraji Gaon Yojana, with 25 lakh structures across 1,995 drains delivered for ₹370 crore [21], and the stronger municipal solid waste system. Odisha has the stronger urban water service model in Sujal and Jalasathi, and a decentralised FSSM system that has achieved treatment capacity of 2,087 KLD against 1,136 KLD of septage generated across 115 ULBs - that is, capacity in excess of generation - while generating revenue and formalising SHG employment [18].

This complementarity is the strongest practical argument for basin-level institutional cooperation that does not depend on resolving the allocation dispute. Cross-State transfer of these two models requires no adjudication, no reallocation of water, and no new statute - only a forum in which it can be organised. It is accordingly proposed in Chapter 7 as an early deliverable of the Phase I Basin Coordination Cell, precisely because it can demonstrate value while the MWDT process runs its course.

3.6 Convergence architecture

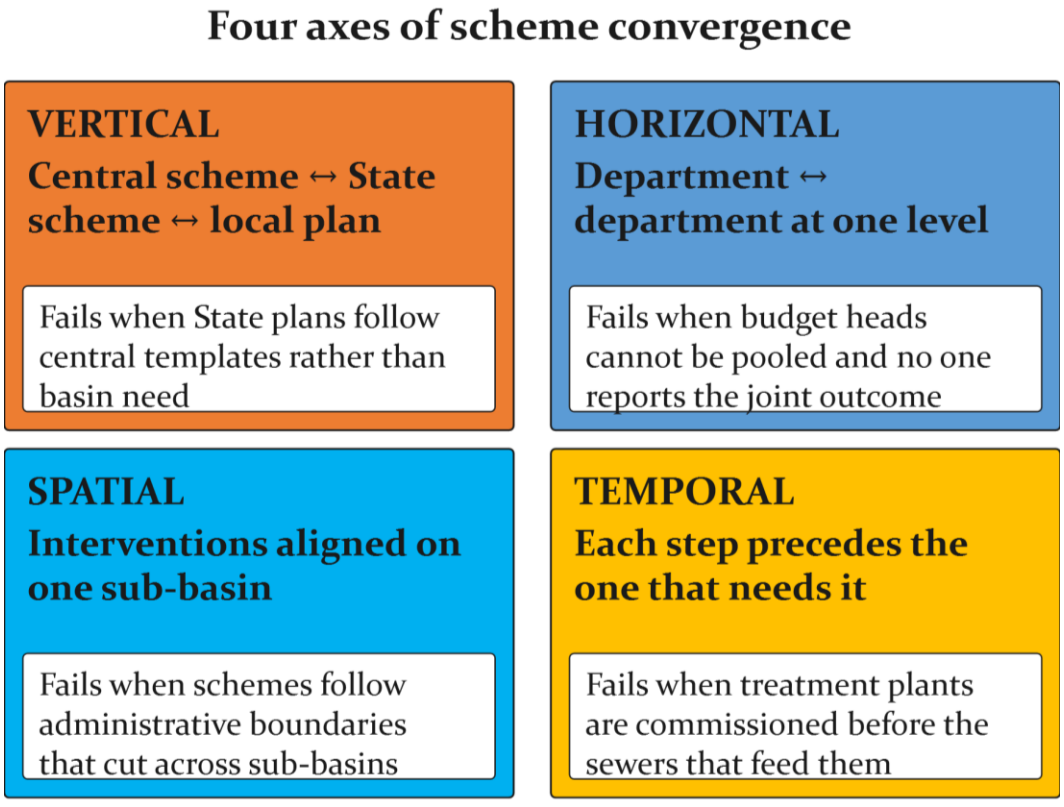
Convergence is used loosely in Indian programme administration to mean any co-location of schemes. For operational purposes it needs to be disaggregated. Four distinct axes of convergence are available in this basin, each with a different authorising authority and a different failure mode.

Of these, temporal convergence is the most neglected and the cheapest to fix. The Infrastructure and Planning Report documents the classic failure in this basin: treatment capacity that is fully or partially underutilised because the sewerage network to feed it does not exist - a pattern the CPCB also identifies nationally [3, 21]. No additional money is required to correct this; only a

sanctioning condition that network and treatment components be commissioned in the correct order, with release of the treatment tranche conditional on network progress.

Table 13 Four axes of scheme convergence and their characteristic failure modes

Axis	Definition	Authorising level	Characteristic failure mode
Vertical	Alignment of central scheme, State scheme and local body plan on the same objective	State department in convergence with Union ministry guidelines	State plan prepared to central guideline templates rather than to basin need; local body treated as implementing agency rather than planner
Horizontal	Alignment across departments at the same level on a shared outcome	Chief Secretary or district collector	Departmental budget heads cannot be pooled; each department reports its own output indicator, so no one reports the joint outcome
Spatial	Alignment of interventions on a common geography - here, the sub-basin	District administration; proposed basin body	Schemes are planned on administrative boundaries that cut across sub-basins, so upstream and downstream works are never sequenced
Temporal	Sequencing of interventions so that each precedes the one that depends on it	Project sanctioning authority	Treatment plants commissioned before sewer networks; riverfronts built before interception; assets created without O&M provision



Temporal convergence is the most neglected and the cheapest to correct: it needs a sanction condition, not more money.

Figure 5 Four axes of scheme convergence and their characteristic failure modes

3.7 Worked convergence combinations

The following five combinations are actionable under existing scheme guidelines and existing executive authority. Each states the components, the mechanism, the outcome and the authority required.

3.7.1 Catchment treatment: MGNREGA + Narva + CAMPA + PMKSY-WDC

Components. MGNREGA water conservation and drainage-line treatment works; the Narva component of Suraji Gaon Yojana; State CAMPA catchment area treatment in forested sub-basins; the Watershed Development Component of PMKSY.

Mechanism. All four fund physically similar works - check dams, gully plugs, contour trenches, farm ponds, afforestation - on the same first- and second-order drainage lines. Convergence means planning them on a single sub-basin drainage map with one works schedule, MGNREGA supplying unskilled labour, CAMPA the plantation component, and PMKSY-WDC and Narva the structural component.

Outcome. Lean-season flow augmentation, reduced sediment yield, groundwater recharge and rural employment. Chhattisgarh has demonstrated the delivery capability: 25 lakh structures

across 1,995 drains covering 7.04 lakh hectares for ₹370 crore, with approximately 50 lakh person-days generated [21].

Authority required. District collector, through the District Water and Sanitation Mission and the MGNREGA labour budget. No new sanction is needed.

3.7.2 Urban wastewater: AMRUT 2.0 + SBM-U 2.0 + NRCP + Finance Commission grants

Components. AMRUT 2.0 for sewerage networks and water-body rejuvenation; SBM-U 2.0 for used-water and faecal sludge management and legacy waste remediation; NRCP for interception and diversion and for treatment in identified polluted stretches; Finance Commission tied grants for O&M.

Mechanism. NRCP identifies the priority stretch and sets the discharge standard; AMRUT funds the network; SBM-U funds septage and legacy waste; the Finance Commission grant is ring-fenced at sanction to fund O&M for the asset life. The critical design feature is that O&M funding is committed at sanction, not sought afterwards - the Infrastructure and Planning Report identifies inadequate funds for spares and electricity, and shortages of skilled manpower, as recurrent causes of treatment plant underperformance [21, and see 3].

Outcome. Reduction in untreated discharge, which in Chhattisgarh stood at 70.23 per cent of approximately 600 MLD generated as of March 2023 [21].

Authority required. State Urban Development Department, with NRCD concurrence on stretch prioritisation. The O&M ring-fencing condition can be imposed by the State sanctioning authority without reference to the Union.

3.7.3 Mining-district environmental restoration: DMF + CAMPA + CSR

Components. District Mineral Foundation funds under PMKKKY high-priority heads (drinking water, environment preservation and pollution control, sanitation); State CAMPA; corporate social responsibility expenditure of the same mining and industrial entities.

Mechanism. The Ib, Hasdeo, Mand and upper Tel sub-basins are simultaneously the basin's principal mining zones, its principal industrial pollution zones and the districts holding the largest DMF balances. With Odisha and Chhattisgarh holding approximately ₹13,728 crore and ₹7,151 crore respectively in accumulated DMF collections, and at least 70 per cent mandated to high-priority sectors including drinking water, environment and sanitation [8], the resources required for environmental restoration in these sub-basins are already collected and already earmarked. The binding constraint is a plan, not a budget. Adding CAMPA - where Chhattisgarh alone held ₹2,596.26 crore unspent as on 1 April 2023 [26], and where Catchment Area Treatment Plan is already a named activity head - brings the indicative combined magnitude available across the two States to the order of ₹32,000 crore (Section 3.2.2).

Outcome. Mine-water management, overburden and sediment control, restoration of degraded catchment, and drinking water security in the most polluted sub-basins.

Authority required. District Mineral Foundation trusts, chaired at district level. This is the single highest-leverage convergence available in the basin because it requires neither central approval nor new appropriation.

3.7.4 Irrigation demand management: PMKSY-PDMC + OIIPCRA + Pani Panchayats

Components. Per Drop More Crop micro-irrigation under PMKSY; OIIPCRA's climate-resilient diversification and water-productivity work; the statutory Pani Panchayat and WUA structure.

Mechanism. Micro-irrigation subsidy and crop-diversification support are delivered through the Pani Panchayat as the unit of planning rather than to individual farmers, with volumetric supply to the distributary and internal allocation by the Pani Panchayat. This converts an efficiency subsidy into a water-saving instrument: without volumetric supply at the offtake, efficiency gains are typically absorbed by area expansion rather than released to the system.

Outcome. Reduced consumptive use per hectare, reduced tail-end deprivation, and diversification away from the paddy-dominated cropping pattern documented in the Revenue Map Report [22].

Authority required. State Department of Water Resources with the Directorate of Agriculture; already partly in place through OIIPCRA's project structure [12].

3.7.5 Decentralised sanitation transfer: Odisha FSSM model + SBM-G II + Fifteenth/Sixteenth FC grants

Components. Odisha's decentralised septage management model, including SHG operation and the SUJOG service platform [18]; SBM-Grameen Phase II's solid and liquid waste management and faecal sludge components, explicitly designed to be dovetailed with Finance Commission grants and MGNREGS [23]; Finance Commission tied grants.

Mechanism. SBM-G II is, by design, a convergence scheme - its own guidelines contemplate dovetailing with Finance Commission and MGNREGS funds [23]. Applying the Odisha operating model, in which SHGs and transgender groups run 109 of 120 septage plants and the platform generates revenue [18], gives the capital works an operating entity and a revenue stream from the outset.

Outcome. Treatment of the septage and greywater streams that neither conventional sewerage nor open defecation elimination addresses, at materially lower capital intensity than networked sewerage.

Authority required. State Panchayati Raj and Drinking Water Departments in both States; the model transfer requires an inter-State arrangement of the kind proposed in Chapter 7.

3.8 Barriers to convergence

Convergence is universally recommended and inconsistently achieved. The barriers in this basin are specific and, in most cases, addressable.

Table 14 Barriers to scheme convergence in the Mahanadi Basin and practicable remedies

Barrier	Manifestation in the Mahanadi Basin	Practicable remedy
Budget head rigidity	Scheme funds carry distinct budget heads, utilisation certificates and audit trails that cannot be pooled into a single works account	Do not pool funds; align works schedules and geographies instead. Each scheme pays for its own component of a jointly planned work
Mismatched planning units	Schemes plan by district and ULB; hydrology operates by sub-basin. Neither state currently reports scheme expenditure against a basin geography	Adopt the sub-basin as a secondary reporting dimension using the CWC sub-basin layer; require a sub-basin tag on every water-related sanction
Asymmetric indicator sets	Each department reports its own output indicator; no agency reports the joint outcome, so convergence produces no measurable credit for anyone	Define a small set of shared basin outcome indicators and report them jointly (Chapter 6)
Sequencing failure	Treatment capacity commissioned ahead of collection networks, producing underutilised assets [21]; riverfront works ahead of interception	Impose sanction conditions linking tranche release to upstream component completion
O&M under-provision	Inadequate provision for spares, electricity and skilled manpower is a recurrent cause of treatment plant failure [21]; municipal water revenue does not cover operating cost [21]	Ring-fence a Finance Commission or own-revenue O&M stream at sanction; make it a condition precedent
Absence of a convening forum	No standing body brings the five to seven agencies with partial mandates together at basin scale (Chapter 2)	Establish the Basin Coordination Cell under existing executive authority (Chapter 7, Phase I)
Loss of the sector-specific grant window	The Sixteenth Finance Commission has discontinued sector-specific and state-specific grants used under the Fifteenth Commission [6]	Shift the funding argument to the performance component of local body grants and to own-source revenue; see Chapter 5

3.9 Summary of Chapter 3

The Mahanadi Basin receives large and growing public expenditure through instruments whose objectives are adjacent to, but not identical with, river condition. The instrument dedicated to river condition is the smallest of them. The practical consequence is that basin restoration in the Mahanadi is principally a problem of directing existing flows rather than of raising new ones - and that the highest-return actions available are those that require no new appropriation: sequencing conditions on sanction, sub-basin tagging of expenditure, ring-fenced O&M, cross-State transfer of the two States' demonstrated models, and deployment of already-collected District Mineral Foundation balances in the sub-basins where they were levied.

4. Economics Involved and its Valuation

4.1 Purpose and limits of economic valuation in this basin

Economic valuation of a river is often defended on the grounds that it reveals a hidden truth about nature's worth. That is not the argument made here. The argument made here is narrower and more practical: basin decisions are already made on economic grounds, but with only one side of the ledger quantified. An industrial water allocation arrives at the decision table with an investment figure, an employment figure and a revenue projection. The foregone downstream irrigation, the reduced dilution capacity, the fisheries impact and the delta salinity consequence arrive with nothing. The outcome of such a comparison is settled before deliberation begins.

Valuation in this chapter therefore serves a specific function: to place the second set of consequences in the same units as the first, so that they can be weighed rather than assumed away. Three constraints follow, and they are stated here because they qualify everything below.

- Valuation is an aid to deliberation, not a substitute for it. A monetised ecosystem service estimate does not settle a distributional question about who bears the loss. Chapter 2 established that the parties bearing basin costs are the least influential; valuation makes their loss visible but does not by itself give them standing.
- Benefit transfer carries error. Several values used below are transferred from studies conducted elsewhere or at State scale. The direction and order of magnitude are informative; the precise figures are not. Every transferred value is labelled as such.
- Unvalued is not valueless. Where a benefit stream could not be valued from a verified Indian source, this chapter reports the switching value - the threshold that benefit must reach for the intervention to break even - rather than inserting an assumed figure. A switching value can be tested against local conditions by the reader; an assumed point estimate cannot.

4.2 The economic significance of the basin

The Mahanadi Basin is economically consequential out of proportion to its area. It supports a population of 38,660,665, of whom 30 per cent are cultivators and 27 per cent agricultural labourers, with 3 per cent industrial workers; scheduled castes constitute 16.5 per cent and scheduled tribes 19.2 per cent of the basin population [21]. Agriculture in Chhattisgarh employs about 80 per cent of the population and contributes roughly 38 per cent of the State economy [21]. The basin simultaneously hosts one of India's densest concentrations of thermal power, iron and steel, aluminium and cement capacity, together with major coal and bauxite extraction.

Four economic systems therefore compete for the same water, and each has a different value density, a different employment intensity and a different political weight.

Table 15 Competing economic systems in the Mahanadi Basin and their water claims

Economic system	Water claim	Employment intensity	Economic characteristics

Irrigated and rainfed agriculture	Approximately 13,715 MCM, being 27.4 per cent of the 50 BCM utilisable surface water and a rise of 24 per cent from 11,057 MCM in 2000-01 [11]	Very high - 30 per cent cultivators plus 27 per cent agricultural labourers [21]	Low value per cubic metre; very high livelihood dependence; fragmented holdings averaging 0.646 ha in the Odisha basin portion and 0.75 ha in rural Chhattisgarh [22]; dominated by paddy
Thermal power, steel, aluminium and cement	Approximately 2,074 MCM allocated, about 4 per cent of utilisable surface water, of which about 1,661 MCM (80 per cent) to thermal power and 413 MCM to iron and steel [11]	Low - about 3 per cent industrial workers [21]	High value per cubic metre; high capital intensity; allocations granted against planned rather than commissioned capacity, creating a claim overhang
Domestic and municipal supply	Growing with urbanisation; Chhattisgarh household sources remain dominated by hand pumps (58.4 per cent) and wells (31.4 per cent) with only 9.8 per cent tap water [21]	Not directly productive but conditions all other activity	Highest priority in law and policy; weakest cost recovery in practice - municipal water revenue does not cover operating cost [21]
Fisheries, wetlands and the delta	Requires flow regime and water quality rather than abstraction - an in-stream rather than off-stream claim	High among the poorest groups; Chilika alone supports large fisher populations	Value entirely dependent on flow and quality; almost never quantified in allocation decisions; the clearest case of an unrepresented economic interest

The asymmetry in this table is the basin's central economic problem. Agriculture holds a water claim roughly seven times that of industry but generates far less value per cubic metre, while industry generates far more value per cubic metre but supports a small fraction of the livelihoods. Neither efficiency alone nor equity alone resolves the allocation question, which is why an allocation rule with published priorities and a compensation mechanism - rather than a case-by-case administrative decision - is recommended in Chapter 6.

4.3 Total Economic Value framework

The Total Economic Value framework decomposes the worth of a river system into components that can be estimated by different methods and, critically, identifies which components are currently captured in basin decisions and which are not.

Table 16 Total Economic Value components for the Mahanadi River Basin and their current treatment

TEV component	Definition	Mahanadi manifestation	Currently captured in decisions?
Direct use - extractive	Value from removing water or biomass from the system	Irrigation abstraction, industrial and municipal supply, capture fisheries, sand mining	Yes, and it dominates. This is the only component routinely quantified
Direct use - non-extractive	Value from in-situ use	Hydropower generation (Hirakud 347.5 MW installed [21]), navigation, bathing and religious use, riverfront recreation, ecotourism at Chilika	Partly. Hydropower is quantified; cultural and recreational use is not
Indirect use	Value from ecological functions supporting other activity	Flood moderation, sediment transport and delta maintenance, dilution and assimilative capacity, groundwater recharge, nutrient cycling, salinity control in the delta	No. These are the services degraded by abstraction and pollution, and none is priced
Option value	Value of retaining the possibility of future use	Retaining unallocated flow against future demand; retaining aquifer storage; retaining the delta's physical integrity	No. Allocations against uncommissioned capacity actively consume option value
Bequest and existence value	Value placed on continuation irrespective of use	Cultural and religious significance of the Mahanadi; Chilika's Ramsar status; endemic and migratory species	No. Occasionally invoked rhetorically, never quantified

The right-hand column contains the finding. Of five TEV components, one is systematically quantified in basin decisions and three are not quantified at all. Since the quantified component is precisely the extractive one, the basin's decision architecture is structurally biased toward extraction. This is not a failure of intent by any agency; it is an arithmetic consequence of what gets counted.

4.4 Valuation methods and their applicability

Table 17 Valuation methods and their applicability to the Mahanadi Basin

Method	What it measures	Applicability in the Mahanadi	Data requirement
Market price / residual imputation	Value of water as a production input	High for irrigation and industrial use; computable from crop budgets and industrial output data	Crop budgets by sub-basin; industrial water use and output - the latter not published

Avoided-cost / replacement-cost	Cost of replacing a lost service by engineering means	Highest immediate applicability. Treatment cost, compensation liability and remediation cost are all published as unit rates	CPCB and NGT unit rates - available and used in Section 4.5
Damage-cost avoided	Health, agricultural and asset losses averted	High, via benefit transfer from the national environmental-degradation assessment	World Bank national estimates [9]; local epidemiological data would improve precision
Benefit transfer	Values imported from comparable studies	Necessary given the absence of basin-specific primary valuation; used with explicit caveat	Odisha land-commons valuation [19]; site-specific studies would be preferable
Contingent valuation / choice experiment	Stated willingness to pay, including non-use value	Not yet conducted for this basin; the principal route to capturing bequest and existence value	Primary household survey - listed as a data requirement in Annexure A
Production function	Contribution of environmental input to measured output	Applicable to fisheries–flow and delta–salinity relationships	Time series of catch, flow and salinity - partially available

4.5 The three anchor unit rates

Three published unit rates carry most of the analytical weight in this chapter. They are set out here because their availability is what makes defensible appraisal possible in a basin lacking primary valuation studies.

4.5.1 Damage rate - the NGT environmental compensation formula

In proceedings on municipal solid waste and sewage management, the National Green Tribunal has fixed environmental compensation at ₹300 per metric tonne of unremediated solid waste and ₹2 crore per MLD of untreated sewage, expressly taking into account the damage caused to the environment [10]. In the Odisha proceedings the Tribunal did not impose compensation after the State undertook to set aside ₹1,138 crore to address gaps in waste management, against a recorded sewage management gap of 146.90 MLD and approximately 26.58 lakh MT of legacy waste awaiting remediation across 33 urban local bodies; the Tribunal noted that details of the ring-fenced account had not been disclosed [10].

This rate is analytically valuable for a reason beyond its legal force. It is an officially determined monetary equivalent of environmental damage, expressed per unit of service gap. It converts a sanitation deficit into a balance-sheet liability, which is the form in which a State finance department can act on it.

4.5.2 Intervention rate - the CPCB treatment cost benchmark

The CPCB's restoration framework estimates capital cost at an average of ₹2.50 crore per MLD for primary, secondary and tertiary treatment, excluding operation and maintenance, across conventional and recent technologies. On a 2015 assessment of 659 towns generating 30,042 MLD against available capacity of 16,846 MLD, the resulting national gap of 13,196 MLD was costed at ₹32,990 crore [3].

An independent cross-check is available. The National River Conservation Plan reports a sanctioned outlay of ₹8,970.51 crore against 3,019 MLD of treatment capacity created [2], implying a derived all-in rate of ₹2.97 crore per MLD. This figure covers interception and diversion, sewerage networks, treatment plants, low-cost sanitation and riverfront works, and is therefore broader in scope than the CPCB treatment-only rate. That the broader figure exceeds the narrower one by only about 19 per cent suggests either that NRCP projects have carried relatively light network components, or that the CPCB rate - which includes tertiary treatment not always provided - is conservative. The two figures are reported together, and not averaged, precisely because they are not measuring the same thing.

4.5.3 Damage-cost rate - the national environmental degradation estimate

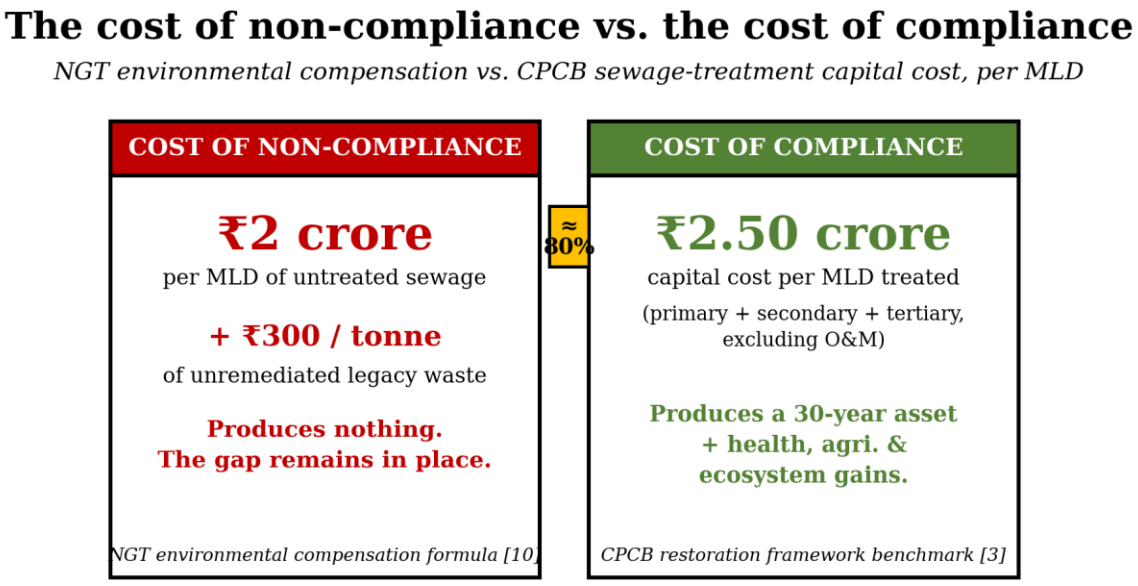
The World Bank's Diagnostic Assessment of Select Environmental Challenges in India, the first national economic assessment of environmental degradation in the country, estimated total degradation cost at about ₹3.75 trillion annually, equivalent to 5.7 per cent of GDP, with health costs attributable to water pollution alone of ₹470–610 billion per year, most associated with diarrhoeal mortality and morbidity among children under five [9].

Normalised to national population, the water-pollution health cost corresponds to approximately ₹336 to ₹436 per person per year (derived). This is a national average across widely varying exposure, and its transfer to a specific basin town requires an attribution assumption, which is made explicit and tested in Section 4.7.

4.5.4 The compliance–non-compliance comparison

Setting the first two anchors side by side produces the most immediately usable result in this report. The compensation assessed for failing to treat one MLD of sewage is ₹2 crore [10]. The capital cost of building the capacity to treat that same MLD is ₹2.50 crore [3]. The cost of non-compliance is therefore approximately 80 per cent of the cost of compliance. The asymmetry is that compliance yields an asset with a service life of the order of thirty years, together with health, agricultural, fisheries and ecosystem benefits, whereas the compensation payment yields nothing at all and leaves the underlying gap in place.

Applied to Odisha's recorded position, the 146.90 MLD sewage gap corresponds to a compensation exposure of roughly ₹294 crore at the NGT rate, against a capital requirement of approximately ₹367 crore at the CPCB rate to eliminate the gap entirely; the 26.58 lakh MT of legacy waste corresponds to a further exposure of about ₹79.7 crore (all derived from [3] and [10]). Against these, the State's undertaking to ring-fence ₹1,138 crore [10] is of a scale sufficient to close the physical gap rather than merely to discharge the liability - which is the correct use of the money and should be the explicit basis on which it is programmed.



Applied to Odisha's recorded 146.90 MLD gap: ₹294 crore in compensation exposure vs. ₹367 crore to build the capacity that removes it - and the State's ₹1,138 crore undertaking is enough to close the gap outright, not merely pay the liability.

Figure 6 The cost of non-compliance compared with the cost of compliance

4.5.5 Applying the anchors: the two States' actual treatment deficit

The anchors above become concrete when applied to the measured position of the two basin States. The CPCB National Inventory of Sewage Treatment Plants, March 2021, records sewage generation, installed capacity and - critically - actual utilisation for every State [32]. The distinction between the second and third of these is where the analytical value lies.

Table 18 Sewage generation, installed capacity and actual treatment in the two basin States

State	Sewage generated (MLD)	Installed STP capacity (MLD)	Installed as % of generation	Actually treated (MLD)	Actually, treated as % of generation
Chhattisgarh	1,203	73	6%	6	0%
Odisha	1,282	378	29%	50	4%
Two basin States	**2,485**	**451**	**18%**	**56**	**2.3%**
All India	**72,368**	**31,841**	**44%**	**20,236**	**28%**

Source: CPCB, National Inventory of Sewage Treatment Plants, March 2021 [32]. Two-State and percentage figures derived. The inventory covers urban centres nationally and is compiled on a different basis from the State-reported figure of about 600 MLD generated in Chhattisgarh as of March 2023 cited in the Infrastructure and Planning Report [21]; the divergence is substantial and is flagged rather than reconciled here, since the two are not measuring the same universe.

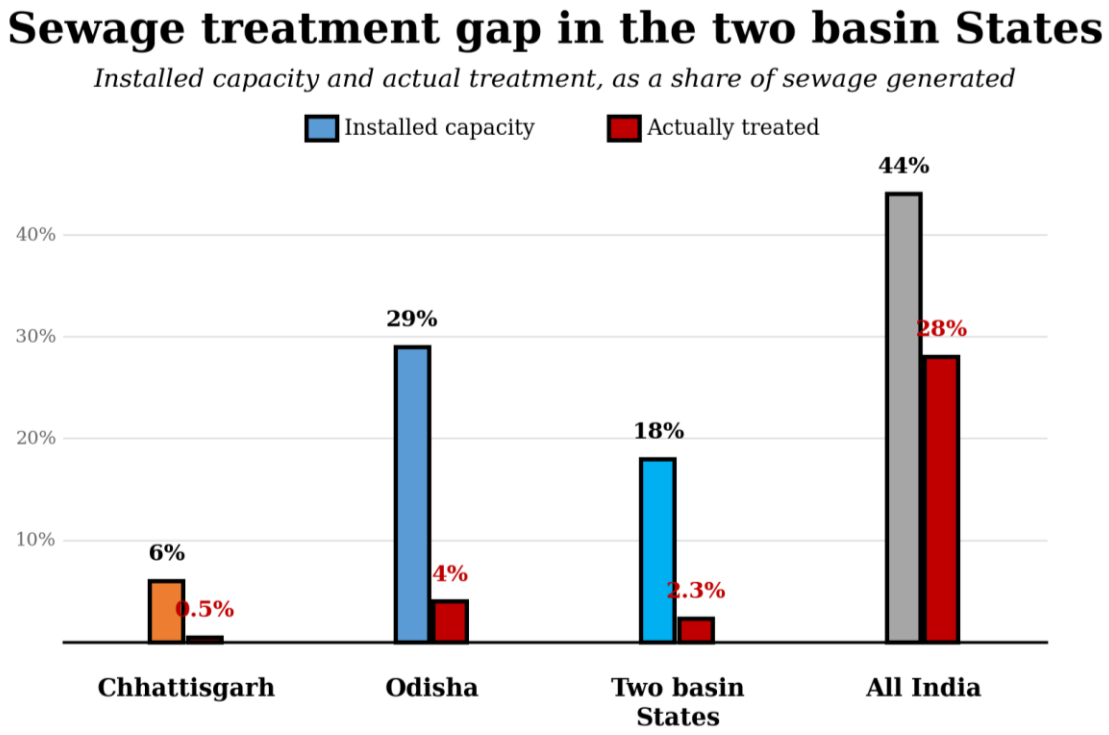
Three conclusions follow, and each sharpens an argument made elsewhere in this report.

First, the basin States are far below the national position. Against a national installed capacity of 44 per cent of generation and actual treatment of 28 per cent, Chhattisgarh and Odisha together have installed capacity for 18 per cent of generation and actually treat 2.3 per cent. On

these figures approximately 2,429 MLD of sewage generated in the two States reaches the environment untreated (derived).

Second, the gap between installed capacity and actual treatment is itself the finding. The two States have built 451 MLD of capacity and use 56 MLD of it. Some 395 MLD of constructed treatment capacity - more than seven times what is actually in use - stands idle (derived). This is the sequencing and O&M failure described in Sections 3.6 and 3.8 expressed in national inventory data, and it is why this report treats network completion, O&M ring-fencing and reuse offtakes as conditions on new capital rather than as refinements. Building more capacity in these two States without addressing utilisation would reproduce the existing position at greater expense.

Third, the arithmetic of closing the gap is favourable and can now be stated precisely. At the NGT rate of ₹2 crore per MLD, the compensation exposure represented by 2,429 MLD of untreated sewage is of the order of ₹4,858 crore. At the CPCB capital rate of ₹2.50 crore per MLD, eliminating the same gap would cost approximately ₹6,072 crore (both derived from [3], [10] and [32]). Set against the indicative ₹32,000 crore of DMF and CAMPA balances already held by the two States (Section 3.2.2), the entire sewage treatment deficit of the Mahanadi basin States could be closed for roughly 19 per cent of funds that have already been collected and earmarked - before any recourse to NRCP, AMRUT, SBM, borrowing or private capital. This single comparison is the strongest available argument that the basin's problem is allocative rather than fiscal.



The two basin States have built 451 MLD of treatment capacity and use 56 MLD of it — 395 MLD, more than seven times what is in use, stands idle. Source: CPCB National Inventory of Sewage Treatment Plants, March 2021 [32].

Figure 7 Sewage treatment gap in the two basin States

4.6 Ecosystem service valuation and the catchment

No primary ecosystem service valuation exists for the Mahanadi Basin. The nearest available anchor is a State-scale assessment of Odisha's land commons, jointly produced by the Foundation for Ecological Security, the International Food Policy Research Institute, Federation University Australia and Common Grounds, which estimated the annual economic value of ecosystem services from nearly five million hectares of land commons at ₹36,890 crore, or about $5 billion [19].

Normalised, this implies an average of approximately ₹73,780 per hectare per year (derived) in ecosystem service value from land commons in Odisha. Four caveats apply and must travel with the figure: it is a State-scale average across heterogeneous land types; it aggregates provisioning, regulating and cultural services that accrue to different parties; it is not specific to riparian or catchment land; and benefit transfer to a particular sub-basin carries substantial error. It is used here only to establish an order of magnitude - but the order of magnitude turns out to be decisive, as Section 4.7.4 shows.

4.6.1 Chilika: a documented restoration precedent in the basin

The basin already contains a large-scale restoration whose outcome is documented, and it is worth setting out because it bears directly on whether the interventions appraised in Section 4.7 can be expected to work. Chilika, a lagoon of between 906 and 1,165 km² receiving the Daya and Bhargavi distributaries of the Mahanadi, underwent rapid degradation between 1950 and

2000 under rising sediment loads and falling salinity: fisheries declined sharply and invasive weeds spread. In 2000 a new mouth to the Bay of Bengal was opened. The Chilika Development Authority records that the intervention restored the salinity regime, raised fish landings, and caused water hyacinth - which had nearly choked the northern sector - to decline rapidly, so that it is now confined to river confluence areas [35].

Two qualifications keep this from being a simple success story, and both are instructive. First, the salinity-tolerant reed Phragmites karka expanded into the space vacated, its area in the northern sector rising from 76.4 km² in 2000 to 105.1 km² by 2010 - about 2.9 km² per year - with sampled biomass rising from 5,068 g/m² in 1990 to 19,040 g/m² in 2001 [35]. A hydrological intervention changed which invasive species dominated rather than eliminating invasion. Second, the northern sector is precisely where the Mahanadi distributaries discharge, so the residual problem is a basin problem rather than a lagoon problem: nutrient and sediment loads generated in the Seonath, Tel and lower main-stem sub-basins arrive here. Chilika cannot be managed to a stable condition by works at Chilika alone.

For the purposes of this chapter the precedent supports a measured conclusion. Physical restoration in this basin demonstrably works and its effects are large; but it displaces rather than removes pressure unless the upstream load is also addressed. That is an argument for the sequencing in Chapter 5 - catchment first, treatment concurrently - rather than against restoration.

4.7 Cost-Benefit Analysis

4.7.1 Method, parameters and conventions

The analyses below follow standard social cost-benefit practice with the following parameters, applied uniformly so that results are comparable across intervention classes.

Table 19 Cost-benefit analysis parameters and conventions

Parameter	Value adopted	Basis
Appraisal horizon	30 years	Approximate service life of civil treatment and water-retention assets; consistent with Indian infrastructure appraisal practice
Social discount rate	8 per cent central; 12 per cent tested	Range commonly applied in Indian public-project appraisal; both are reported rather than one being preferred
Annuity factor (30 years)	11.258 at 8 per cent; 8.055 at 12 per cent	Derived
Price basis	Constant prices; benefits and costs both in real terms	Avoids inflation assumptions that cannot be verified
Capital phasing	Assumed incurred in year 0	Simplification; multi-year phasing would modestly improve all reported ratios
O&M	Expressed as a percentage of capital	Assumption. No verified Indian ₹/MLD/year O&M benchmark was located; the sensitivity

	cost, tested at 4, 6 and 8 per cent per year	range is reported in full rather than a single figure being asserted
Unvalued benefits	Reported as switching values	Where a benefit stream cannot be valued from a verified source, the threshold required for break-even is computed instead

These analyses are method demonstrations calibrated on published unit rates. They establish orders of magnitude and identify which parameters decide the outcome. They are not project appraisals and must not be used in place of a site-specific Detailed Project Report.

4.7.2 CBA 1 - Municipal sewage treatment, 100 MLD basin town

Scheme definition. A 100 MLD sewage treatment facility in a basin town. At the CPHEEO norm of 135 lpcd with an assumed 80 per cent return to sewer, 100 MLD corresponds to a served population of approximately 0.93 million (derived).

Costs. Capital cost of ₹250 crore at the CPCB rate of ₹2.50 crore per MLD [3]. Annual O&M at 4, 6 and 8 per cent of capital.

Quantified benefits. Two streams can be valued from verified sources. First, avoided environmental compensation of ₹200 crore, being 100 MLD at the NGT rate of ₹2 crore per MLD [10], treated as accruing in year 0. Second, avoided health cost of approximately ₹12.6 crore per year, derived as 0.93 million persons multiplied by the midpoint per-capita water-pollution health cost of ₹386 [9], multiplied by an attribution factor of 35 per cent to reflect that municipal sewage treatment addresses only part of the water-pollution exposure pathway.

Unvalued benefits. Treated-water reuse revenue; agricultural benefit from improved irrigation water quality; fisheries recovery; recreational and cultural value of a restored reach; property value effects; avoided defensive expenditure by households on point-of-use treatment. Of these, reuse revenue is the one that can be designed into the scheme, and it is therefore the one for which a switching value is computed.

Table 20 CBA 1 - Sensitivity and switching values for a 100 MLD municipal sewage treatment scheme

Discount rate	O&M rate	Cost NPV (₹ crore)	Quantified benefit NPV (₹ crore)	BCR on quantified benefits	Reuse tariff needed for BCR = 1 (₹/m³)
8%	4%	362.6	341.4	0.94	0.86
8%	6%	418.9	341.4	0.81	3.14
8%	8%	475.2	341.4	0.72	5.42
12%	4%	330.6	301.2	0.91	1.66
12%	6%	370.8	301.2	0.81	3.95
12%	8%	411.1	301.2	0.73	6.23

Switching value assumes 60 per cent of treated flow (60 MLD, being 21.9 million m³ per year) is sold for reuse. Derived from [3], [9] and [10] on the parameters set out in Section 4.7.1.

Interpretation. On quantified benefits alone the scheme does not reach break-even under any tested combination, returning benefit-cost ratios between 0.72 and 0.94. This is an honest and

important result, and it should not be read as a finding that sewage treatment is uneconomic. It is a finding about how such schemes must be structured. The gap closes at a treated-water reuse tariff of between ₹0.86 and ₹6.23 per cubic metre depending on O&M intensity and discount rate. Given the concentration of thermal power, steel and aluminium capacity in this basin - industries that collectively hold allocations of about 2,074 MCM [11] and that purchase water well above this range - the decisive design decision is whether the plant is built with a committed industrial reuse offtake or as a disposal facility. A plant built with an offtake agreement is economically robust; the same plant built without one is not.

Two further observations follow. First, the results are far more sensitive to O&M intensity than to the discount rate: moving O&M from 4 to 8 per cent costs more benefit-cost ratio than moving the discount rate from 8 to 12 per cent. This confirms the emphasis placed on ring-fenced O&M provision in Section 3.8. Second, the unvalued benefit streams listed above are real and in aggregate substantial; a scheme showing 0.94 on two quantified streams is very likely above unity in truth. The switching-value presentation is intended to let an appraiser reach that judgement transparently rather than have it assumed for them.

4.7.3 CBA 2 - Nala and catchment treatment (Narva model)

Scheme definition. Drainage-line and catchment treatment on the model actually delivered in Chhattisgarh, where over 25 lakh groundwater augmentation structures were constructed in 2019-20 and 2020-21 at a cost of ₹370 crore, covering 7.04 lakh hectares across 1,995 drains, with approximately 50 lakh person-days of employment generated [21]. This is the only major basin intervention for which both a delivered cost and a delivered area are published, which makes it the most reliable of the four analyses.

Unit cost. ₹370 crore over 7.04 lakh hectares gives ₹5,256 per hectare (derived) - roughly two orders of magnitude below the per-hectare cost of engineered irrigation supply.

Costs. Capital of ₹370 crore with O&M at 2 per cent per year, reflecting the low maintenance requirement of small water-retention structures relative to mechanical treatment assets.

Switching value. The break-even incremental benefit required is approximately ₹572 per hectare per year at an 8 per cent discount rate, and ₹758 per hectare per year at 12 per cent (derived).

Table 21 CBA 2 - Break-even thresholds for nala and catchment treatment on the delivered Narva cost base

Discount rate	Capital (₹ crore)	Cost NPV (₹ crore)	Annualised cost (₹ crore)	Break-even benefit (₹/ha/year)
8%	370	453.3	40.27	572
12%	370	429.6	53.33	758

Interpretation. A threshold of ₹572 to ₹758 per hectare per year is very low. It would be cleared by a marginal improvement in yield on a fraction of the treated area, by a modest reduction in pumping cost from improved shallow groundwater levels, or by the avoided cost of a single supplementary irrigation. It does not need to be cleared by all three. Moreover, the threshold is computed before counting the approximately 50 lakh person-days of employment the

programme generated [21], which is a benefit already realised and independently valuable given the basin's dependence on agricultural labour.

A further benefit stream, not counted in the threshold above, is avoided reservoir sedimentation. Hirakud traps approximately 79 per cent of the sediment reaching it, and loses live storage at an average of about 0.75 per cent - some 61.0 MCM - per year. The reservoir has already lost about 34 per cent of its live storage since impoundment in 1957, and the area-reduction method projects losses of 58 per cent of live storage, 63 per cent of gross storage and 100 per cent of dead storage by 2057, a century after impoundment [34]. Since catchment treatment reduces sediment yield, its benefits include deferring the loss of the basin's principal storage asset. This is the clearest instance in the basin of an upstream intervention whose benefit accrues to an identifiable downstream party - and therefore the natural candidate for the Payment for Ecosystem Services pilot proposed in Section 5.9, in which the reservoir operator pays upstream catchment managers for storage protected.

This is the strongest economic result in the report, and it has a direct policy implication. Catchment treatment in the Mahanadi Basin is economically robust by a wide margin, is deliverable through existing convergence of MGNREGA, Narva, CAMPA and PMKSY-WDC (Section 3.7.1), and requires no new appropriation. Where basin investment is constrained, this is where the first rupee should go.

4.7.4 CBA 3 - Legacy solid waste remediation

Scheme definition. Remediation of legacy waste dumpsites in basin towns, taking Odisha's recorded 26.58 lakh MT across 33 ULBs as the reference quantum [10].

Avoided liability. At the NGT rate of ₹300 per metric tonne, the compensation exposure on this quantum is approximately ₹79.7 crore (derived from [10]).

Analysis. Biomining and remediation unit costs in India were not verified from an official source for this report, and are therefore not asserted. The structure of the decision can nonetheless be stated precisely: remediation is justified on avoided compensation alone wherever the delivered unit cost is below ₹300 per metric tonne. Where the delivered cost exceeds that threshold, the case rests on three additional benefit streams that are real but were not valued here - recovery of the occupied land for productive use, which in peri-urban basin towns is frequently the largest single benefit; avoided groundwater and surface water contamination from leachate, which is the direct river-condition benefit; and avoided methane emissions.

The practical recommendation follows from the structure rather than from a computed ratio: procure remediation on a per-tonne basis and use ₹300 per tonne as the reference price against which bids are assessed, requiring positive justification through land value or contamination risk wherever bids exceed it. The verified unit cost of remediation in each State is listed in Annexure A as a required dataset.

4.7.5 CBA 4 - Catchment and riparian ecosystem restoration

Scheme definition. Restoration of degraded catchment and riparian land through afforestation, bamboo regeneration for bank stabilisation, and community-managed commons restoration -

the intervention class already being delivered in the basin through State Forest programmes and the World Bank-supported Ecosystem Services Improvement Project [21].

Benefit anchor. The Odisha land-commons assessment implies approximately ₹73,780 per hectare per year in ecosystem service value (derived from [19]), subject to the four caveats set out in Section 4.6.

Cost anchor. Taking the delivered Narva unit cost of ₹5,256 per hectare [21] as a lower-bound proxy for restoration works of this kind, and recognising that afforestation and riparian works are typically more expensive per hectare than drainage-line structures.

Interpretation. Even applying a severe attribution discount - attributing only 10 per cent of the land-commons service value to the restoration intervention, and only to the treated hectare - the resulting benefit of roughly ₹7,378 per hectare per year exceeds the one-time treatment cost of ₹5,256 per hectare within the first year. The conclusion is not sensitive to the discount rate, to the appraisal horizon, or to reasonable variation in the attribution factor: catchment and riparian restoration in this basin clears economic justification by a margin large enough that the benefit-transfer error does not change the decision.

The appropriate caution is directional rather than arithmetic. The land-commons valuation includes provisioning services that accrue to the households using the commons; a restoration programme that excludes those households from use would not generate the valued benefit. The economic case for restoration is therefore also a case for community-managed restoration - which aligns with the Forest Rights Act gram sabha authority identified in Section 2.7 and with the community-based natural resource management recommendation of the Revenue Map Report [22].

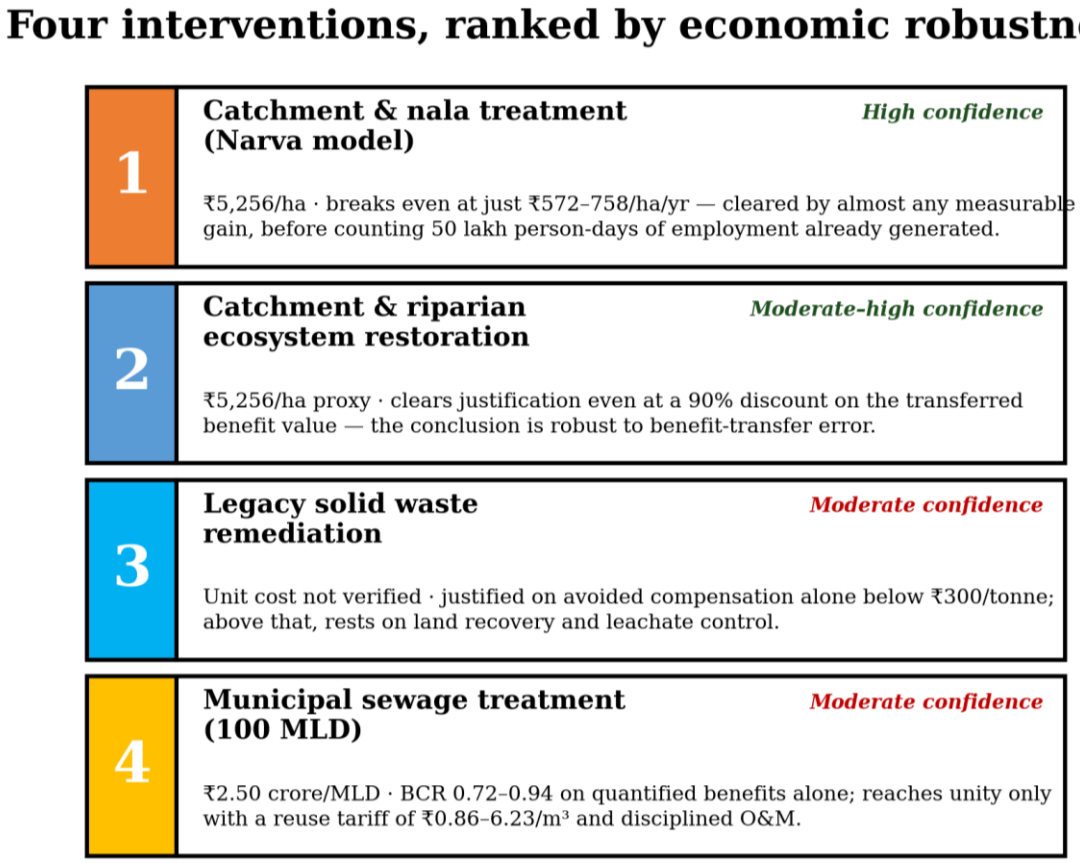
4.7.6 Comparative summary and investment ordering

Table 22 Comparative economic assessment of four intervention classes

Intervention class	Cost basis	Economic verdict	Confidence
Catchment and nala treatment (Narva model)	₹5,256/ha delivered [21]	Break-even at ₹572–758/ha/year; cleared by any measurable agricultural or recharge gain, before counting 50 lakh person-days of employment already generated	High - delivered cost and delivered area both published
Catchment and riparian ecosystem restoration	₹5,256/ha proxy [21]	Clears justification even at a 90 per cent attribution discount on the transferred service value; conclusion robust to benefit-transfer error	Moderate-high - cost solid, benefit transferred from State-scale study [19]
Legacy solid waste remediation	Not verified	Justified on avoided compensation alone below ₹300/MT; above that, rests on land recovery and leachate control	Moderate - decision rule is sound; unit cost requires verification

Municipal sewage treatment, 100 MLD	₹2.50 crore/MLD [3]	BCR 0.72–0.94 on quantified benefits alone; reaches unity at a reuse tariff of ₹0.86–6.23/m³. Viability turns on securing an industrial reuse offtake and on controlling O&M intensity	Moderate - costs well sourced; several large benefit streams unvalued

The ordering that emerges is clear and, notably, is close to the inverse of the ordering by which basin investment is usually discussed. Catchment interventions are cheapest per unit area, most economically robust, most employment-intensive and least dependent on institutional sophistication - yet they attract the least attention. Treatment plants are the most expensive, the most institutionally demanding, the most vulnerable to O&M failure and the least certain economically - yet they dominate the discourse. The recommendation that follows is not to abandon treatment, which is legally required and addresses a load that catchment works cannot touch, but to sequence catchment investment first and concurrently, and to structure treatment investment around reuse offtakes and guaranteed O&M.



The ordering is close to the inverse of how basin investment is usually discussed: catchment works are cheapest and most robust yet attract the least attention; treatment plants are the most expensive and least certain yet dominate the discourse.

Figure 8 Four interventions ranked by economic robustness

4.8 What could not be valued, and what it would take

The following benefit streams are material to the basin and could not be valued from verified sources for this report. Each is listed with the study or dataset that would close the gap; the consolidated list appears in Annexure A.

- Environmental flow value. The economic cost of reduced lean-season flow, expressed through fisheries yield, dilution capacity and delta salinity. Requires a flow–catch–salinity time series and a production function study.
- Delta and Chilika ecosystem services. No basin-specific valuation exists for the Mahanadi delta or for Chilika as a receiving system. A site-specific study would replace the State-scale transfer used in Section 4.6.
- Industrial water productivity. Value added per cubic metre by industry type is not published, which makes it impossible to compare industrial and agricultural water productivity rigorously - the central question in every allocation dispute in the basin.
- Non-use value. No contingent valuation or choice experiment has been conducted for the Mahanadi. This is the only route to capturing the bequest and existence components of the Total Economic Value framework.
- O&M unit costs. No verified Indian ₹ per MLD per year benchmark for STP operation was located; this parameter decides the sewage-treatment result and is therefore the single most valuable missing number in this chapter.
- Remediation unit costs. Verified per-tonne biomining and legacy waste remediation costs for the two States.

4.9 Summary of Chapter 4

The basin's decision architecture quantifies extractive use and leaves indirect use, option value and non-use value entirely unpriced, which biases allocation toward extraction as a matter of arithmetic rather than intent. Three published unit rates - the NGT compensation formula, the CPCB treatment cost benchmark and the World Bank degradation estimate - are sufficient to bring the second side of the ledger into the discussion without waiting for primary valuation studies. Applied to four intervention classes, they show that catchment treatment is economically robust by a very wide margin at about ₹5,256 per hectare, that ecosystem restoration clears justification even under severe attribution discounting, that legacy waste remediation has a clean decision rule at ₹300 per tonne, and that municipal sewage treatment is viable but conditional - on securing a reuse offtake and on controlling O&M.

5. Funding Models

5.1 The financing question, correctly posed

Chapter 3 established that the Mahanadi Basin is not primarily short of public money; it is short of directed public money. Chapter 4 established that the intervention classes with the strongest economics - catchment and riparian treatment - are also the cheapest, while the intervention class with the weakest standalone economics - municipal sewage treatment - is the most capital-

intensive and the most dependent on sustained operating expenditure. Together these findings reframe the financing question. It is not "how do we raise money for the basin?" but three sharper questions:

1. How is capital mobilised for treatment assets whose standalone economics are conditional?
2. How is operating expenditure secured for the full asset life, given that O&M intensity has been shown to decide the economic result and that municipal water revenue currently does not cover operating cost [21]?
3. How are catchment and community works financed, given that they are economically the strongest but commercially the least bankable, since their benefits are diffuse, non-excludable and accrue to parties who cannot pay?

Each of the seven models assessed below answers one or two of these questions well and the others badly. That is why the chapter concludes with a layered architecture rather than a preferred model.

5.2 The changed fiscal context

Two developments materially alter the financing landscape for this basin and should condition every financing decision taken from 2026 onward.

The Sixteenth Finance Commission has discontinued sector-specific and state-specific grants. Its report, tabled in Parliament on 1 February 2026 for the period 2026-27 to 2030-31, recommends total grants of ₹9.47 lakh crore, comprising ₹4.4 lakh crore for rural and ₹3.6 lakh crore for urban local bodies, divided into a basic component of 80 per cent and a performance-based component of 20 per cent, with the urban share rising from 36 per cent under the Fifteenth Commission to 45 per cent. It has discontinued the revenue deficit, sector-specific and state-specific grants recommended by its predecessor [6].

The consequences for the basin are precise and cut both ways. On the negative side, the Fifteenth Commission's tied grant of ₹1,42,084 crore to rural local bodies specifically for water and sanitation [7] has no direct successor, and the state-specific grant window through which a basin-level proposal might have been advanced is closed. On the positive side, the larger urban share and the 20 per cent performance component create an opening: if basin-relevant service indicators are adopted as performance criteria at State level, the performance component becomes an instrument for basin outcomes without any new scheme being created. Securing that is a Phase I action in Chapter 7.

Jal Jeevan Mission has been restructured and extended. The enhanced outlay of ₹8.69 lakh crore to December 2028, with central assistance of ₹3.59 lakh crore, and an explicit focus on structural reforms in the rural drinking water sector [5], creates a window in which source sustainability works - which are catchment works by another name - can be funded at scale in basin villages.

5.3 Model A - Budgetary and Centrally Sponsored Scheme finance

Structure. Direct appropriation through State budgets and central scheme transfers on prescribed cost-sharing ratios.

Strengths. Requires no new institutional capacity; absorbs large volumes; suited to non-revenue-generating assets; the only realistic source for works in low-capacity local bodies.

Weaknesses. Annual appropriation cycles conflict with multi-year construction; capital is provided far more readily than O&M, which is the failure mode identified in Chapter 4; and the budget-head rigidity documented in Section 3.8 obstructs convergence.

Best use in this basin. Rural sanitation, rural water supply, catchment works, and any intervention in a local body without the capacity to manage a contract-based model.

5.4 Model B - Hybrid Annuity Model and One City One Operator

Structure. Under the Hybrid Annuity Model as applied to the Indian water sector for the first time under Namami Gange, the public authority pays approximately 40 per cent of project cost during construction against milestones, and the remaining 60 per cent is paid to the concessionaire as annuities over fifteen years together with operation and maintenance expenses [13]. The One City One Operator variant integrates newly developed treatment assets with a city's existing sewage infrastructure under a single operator, and has been applied in Prayagraj, Kanpur, Howrah-Bally-Baranagar and Kamarhati, with hybrid annuity projects developed across 29 cities in 18 packages [13].

Strengths. This model directly addresses the two weaknesses that Chapter 4 identified as decisive for sewage treatment. It transfers O&M risk to the party best able to manage it and guarantees O&M funding for fifteen years by contract rather than by annual appropriation. It brings private capital and operating capability, and the One City One Operator structure eliminates the fragmentation of responsibility between old and new assets that has undermined operating performance elsewhere.

Weaknesses. It requires a creditworthy public counterparty capable of honouring annuities for fifteen years - a demanding requirement given the municipal financial position documented in Chapter 2. It requires procurement and contract-management capability that most basin ULBs do not currently hold. And it is viable only at a scale sufficient to attract competent bidders.

Best use in this basin. Treatment and sewerage in the larger basin urban centres - Raipur, Bilaspur, Bhubaneswar, Cuttack, Sambalpur, Rourkela - where scale is sufficient and where the counterparty can be a State-level entity such as OWSSB or WATCO rather than an individual ULB. Structuring the annuity obligation at State entity level rather than ULB level is the single design choice that determines whether this model is available in the Mahanadi Basin at all.

5.5 Model C - Municipal green bonds and pooled finance

Structure. Debt raised by an urban local body against its own revenue stream, with proceeds ring-fenced to environmentally qualifying projects. SEBI formalised issuance rules in 2015, requiring credit ratings and disclosures [14].

Precedent. Ghaziabad issued India's first certified municipal green bond of ₹150 crore in 2021 for sewage treatment infrastructure; Indore followed with ₹244 crore in 2023; and Ahmedabad and Vadodara raised ₹200 crore and ₹100 crore respectively in February 2024 for water treatment and climate-resilient urban services. The Ministry has released ₹377.33 crore as incentive across the issuances by Ahmedabad, Ghaziabad, Indore, Pimpri Chinchwad and Vadodara. Analysis by the CEEW Green Finance Centre assesses that the Indian municipal green bond market could mobilise up to $2.5 billion with appropriate reform, though municipal green bonds currently account for less than 10 per cent of the ₹11,023 crore of green bonds issued in India as of 31 December 2025 [14].

Strengths. Mobilises capital against future revenue rather than current appropriation; imposes financial discipline and disclosure that improve municipal management generally; the central incentive materially improves the effective cost of funds.

Weaknesses. Requires a credit rating, audited accounts and a demonstrable revenue stream. The Infrastructure and Planning Report's findings on basin ULBs - water revenue insufficient to cover operating cost, absence of metering for commercial and high-volume users, high non-revenue water, and weak accounting practice [21] - describe precisely the conditions under which a bond cannot be issued.

Best use in this basin. Not immediately available to most basin ULBs, and it is important to say so plainly rather than list it as an option. It becomes available only after the revenue reforms it presupposes. The correct sequencing is therefore metering and tariff reform first, creditworthiness second, bond issuance third - which is why Odisha's Sujal and Jalasathi programmes [17], by building a metered and billed urban customer base, are more important to the basin's long-run financing capacity than they appear.

5.6 Model D - Ring-fenced basin fund from DMF, CAMPA and CSR

Structure. A dedicated fund pooling District Mineral Foundation allocation under PMKKKY high-priority heads, State CAMPA disbursements, and corporate social responsibility contributions from basin industry, governed against a published basin plan.

Scale. DMF collections stood at approximately ₹13,728 crore in Odisha and ₹7,151 crore in Chhattisgarh against a cumulative national figure of about ₹1.02 lakh crore to November 2024, with at least 70 per cent of DMF funds required to be spent in mining-affected areas on high-priority sectors including drinking water, environment preservation and pollution control, and sanitation [8]. On the CAMPA side, the two States received the two largest shares of the ₹47,436 crore transferred to 27 States and Union Territories in August 2019 - Odisha ₹5,933.98 crore and Chhattisgarh ₹5,792 crore [27] - and Chhattisgarh alone still held ₹2,596.26 crore unspent as on 1 April 2023 [26]. The indicative combined magnitude is on the order of ₹32,000 crore (Section 3.2.2).

Strengths. This is the most under-exploited financing opportunity in the basin, for three reasons. The money is already collected, so no new levy or appropriation is required. It is already earmarked to purposes that align closely with basin needs. And it is held precisely where it is needed - the districts with the largest DMF balances are the mining districts of the Ib, Hasdeo,

Mand and upper Tel sub-basins, which are simultaneously the basin's principal industrial pollution and land degradation zones. It is also the natural instrument through which the polluter-pays principle operates at basin scale without new legislation.

Weaknesses. These are real and are the reason this model is described here as under-exploited rather than as easy. DMF governance is district-bound, so a sub-basin spanning several districts requires coordination across several trusts, and the allocation is a political decision at district level in which a basin claim competes against health, education and other legitimate high-priority uses. Independent assessment has identified gaps in DMF planning and utilisation [8]. On the CAMPA side the constraint is sharper still: nationally only 52 per cent of approved plan value had been utilised by December 2024 [29], and the Comptroller and Auditor General found that Odisha's State CAMPA left ₹210.54 crore of ₹2,284.98 crore unutilised during 2019-22, had not finalised annual accounts since inception in 2009, irregularly applied ₹56.82 crore to construction works, diverted ₹248.06 crore to another State scheme, and conducted no monitoring or evaluation activity in the period [28].

The implication is that this model requires an absorption strategy, not a fundraising strategy. Where other models in this chapter are constrained by the availability of capital, Model D is constrained by plans, technical capacity and accounts. That is a materially easier problem to solve, and it is one the Basin Coordination Cell proposed in Chapter 7 is well suited to address by preparing the sub-basin restoration plans that DMF trusts and State CAMPA authorities currently lack.

Best use in this basin. Catchment restoration, mine-water and sediment management, drinking water security and sanitation in the mining sub-basins - the intervention classes Chapter 4 found most economically robust and least commercially bankable. This model and Model A between them should carry the entire catchment programme.

5.7 Model E - Concessional and blended development finance

Structure. Sovereign-guaranteed concessional loans and grants from multilateral and bilateral institutions, on-lent or transferred to State implementing entities.

Precedent in this basin. The World Bank's $165 million Odisha Integrated Irrigation Project for Climate Resilient Agriculture, signed in 2019, supporting about 125,000 smallholder households across 15 districts managing approximately 128,000 hectares [12]; the World Bank-supported Ecosystem Services Improvement Project [21]; JICA-assisted urban sanitation works in the basin [21]; and NABARD's Rural Infrastructure Development Fund. The Orissa Water Resources Consolidation Project historically drove the creation of the Pani Panchayat structure through its Farmers Organisation and Turnover component [11].

Strengths. Long tenor and concessional pricing suited to assets with long payback; technical assistance and appraisal discipline that typically improve project design; and - as the Pani Panchayat history demonstrates - an ability to drive institutional reform as a loan condition that domestic financing rarely achieves.

Weaknesses. Long preparation cycles; State borrowing limits; safeguard compliance costs; and the risk that reform commitments made as loan conditionalities are formally satisfied without

being substantively implemented, which the documented gap between the Pani Panchayat statute and field practice illustrates [11, 21].

Best use in this basin. Large integrated programmes combining infrastructure with institutional reform, and specifically an integrated Mahanadi basin programme of the kind that would give a Phase II basin organisation (Chapter 7) both a mandate and a budget.

5.8 Model F - Cost recovery, tariffs and the polluter-pays principle

Structure. Recovery of operating and, progressively, capital cost from users through volumetric water tariffs, bulk raw-water charges to industry, sewerage cess, and charges reflecting pollution load.

Current position. Weak. Municipal water revenue does not cover operational cost; metering is absent for commercial and high-consumption users; non-revenue water is high; and there is no incentive to reduce waste [21]. On the raw-water side, Odisha operates a licensing regime for industrial and commercial abstraction from government water sources under amendments to the Orissa Irrigation Act, with the Executive Engineer empowered to order installation of a flow meter within ninety days at the establishment's cost [11] - the legal foundation for volumetric charging therefore exists; what is missing is comprehensive application.

Strengths. Cost recovery is the only financing model that is self-sustaining, that scales with consumption, and that simultaneously creates a conservation incentive. It is also the precondition for Models B and C: neither an annuity obligation nor a bond can be serviced without a revenue stream.

Weaknesses. Politically difficult; requires metering infrastructure that does not exist; and raises genuine affordability questions for poor households, which must be addressed through targeted lifeline provision rather than through universal under-pricing.

The position differs materially between the two States, and this is a finding rather than a detail. Odisha has an explicit statutory route to volumetric measurement of industrial surface-water abstraction. Chhattisgarh does not. Its principal water-regulation statute, the Chhattisgarh Ground Water (Management and Regulation) Act, 2022 (Act No. 18 of 2022), assented on 29 September 2022 and published on 7 November 2022, establishes Bhoojal Samitis and a bulk-user category, but regulates ground water only [30]. A draft Chhattisgarh Water Sustainability Bill covering the wider sector has been placed in the public domain by the State Water Resources Department but is not recorded as enacted [31]. The Department does publish water-rate notifications and water-allocation forms and procedures, and industrial water in notified industrial areas is billed [31], so charging occurs; what could not be verified from an accessible official source is a mandatory metering obligation on surface-water abstraction equivalent to Odisha's. Establishing whether such a provision exists in departmental circulars, and enacting one if it does not, is therefore a specific recommendation for Chhattisgarh.

Best use in this basin. Two applications are immediately available and should be pursued ahead of general tariff reform. First, volumetric metering and charging of industrial raw-water abstraction, which can proceed immediately in Odisha under existing powers [11] and requires an enabling provision in Chhattisgarh; in both States the number of counterparties is small,

ability to pay is not in question, and the revenue can be hypothecated to basin works. Second, treated-water reuse sale to industry, which Chapter 4 identified as the decisive variable in sewage treatment viability and which converts a cost centre into a revenue centre.

5.9 Model G - Payment for Ecosystem Services and environmental markets

Structure. Payments from downstream beneficiaries to upstream land managers for maintaining catchment services, and participation in carbon or biodiversity markets for restoration works.

Rationale in this basin. Chapter 4 established both halves of the required logic: catchment treatment is very cheap at about ₹5,256 per hectare [21], and ecosystem services from land commons are very valuable at an implied order of ₹73,780 per hectare per year [19]. The beneficiaries of catchment condition - downstream urban water utilities, industrial abstractors, reservoir operators facing siltation, and the hydropower operation at Hirakud - are identifiable and are able to pay. The providers - upstream forest-dwelling and farming communities with Forest Rights Act gram sabha authority - are also identifiable and organised.

Weaknesses. No PES scheme of this kind currently operates in the basin; establishing the service-to-payment link requires monitoring capability that does not yet exist; and carbon market access requires methodological compliance and aggregation across many small holdings.

Best use in this basin. A pilot in a single sub-basin with a clearly identifiable downstream beneficiary - the most obvious candidate being siltation reduction upstream of a major reservoir, where the avoided cost of lost storage is calculable and accrues to a single identifiable operator. This is proposed as a Phase II action in Chapter 7.

5.10 Comparative assessment

Table 23 Comparative assessment of seven financing models against basin conditions

Model	Capital mobilisation	O&M security	Institutional demand	Equity effect	Basin readiness
A - Budgetary and CSS	High volume	Weak	Low	Neutral to positive	Available now
B - HAM / One City One Operator	High	Strong - contractual for 15 years	High	Neutral; depends on tariff design	Available at State-entity level; not at most ULBs
C - Municipal green bonds	Moderate	Moderate	High	Depends on tariff design	Not yet - requires prior revenue reform
D - DMF / CAMPA / CSR basin fund	Moderate to high	Moderate	Moderate	Strongly positive - funds flow to mining-	Available now - funds already

				affected communities	collected and earmarked
E - Concessional and blended finance	High	Moderate	High	Positive where targeted at smallholders	Available with 18–36 month preparation
F - Cost recovery and polluter-pays	Low directly; enables B and C	Strong	Moderate	Regressive unless lifeline provision is designed in	Partly - legal basis exists in Odisha for industrial abstraction [11]
G - PES and environmental markets	Low to moderate	Moderate	High	Strongly positive - transfers to upstream communities	Pilot stage only

5.11 Proposed Mahanadi Basin Financing Architecture

No single model serves the basin. The architecture below assigns each intervention class to the model or combination that fits its economic and institutional characteristics, and is designed so that each layer can proceed independently of the others.

Table 24 Proposed layered financing architecture for the Mahanadi River Basin

Layer	Intervention class	Primary financing	Secondary / enabling	Sequencing
1. Catchment and commons	Nala and drainage-line treatment, afforestation, riparian and bank stabilisation, community commons restoration	Model A (MGNREGA, Narva, PMKSY-WDC, JJM source sustainability) + Model D (DMF, CAMPA)	Model G pilot in one sub-basin	Immediate. Strongest economics, funds already available, no new institution required
2. Rural sanitation and water	ODF Plus, greywater and faecal sludge management, rural piped supply	Model A (SBM-G II, JJM 2.0) + Sixteenth FC basic grant	Odisha SHG operating model transferred to Chhattisgarh	Immediate. SBM-G II is designed for convergence with FC grants and MGNREGS [23]
3. Urban treatment and networks	Sewerage networks, STPs, septage systems, legacy waste remediation in basin towns	Model B at State-entity level for large towns; Model A for small towns	Model F reuse offtake contracted at design stage; Sixteenth FC performance grant for O&M	Sequenced. Network before treatment; reuse offtake before financial close

4. Irrigation efficiency	Micro-irrigation, canal modernisation, crop diversification, volumetric supply to distributaries	Model E (OIIPCRA-type operations) + Model A (PMKSY)	Delivery through Pani Panchayats; Model F volumetric charging at offtake	Medium term. Requires Pani Panchayat strengthening to be effective
5. Institutional and data	Basin data platform, water accounting, monitoring network, basin organisation running costs	Model E technical assistance + Model A	NRCP as convener and quality assurer	Immediate and continuing. Precondition for everything above

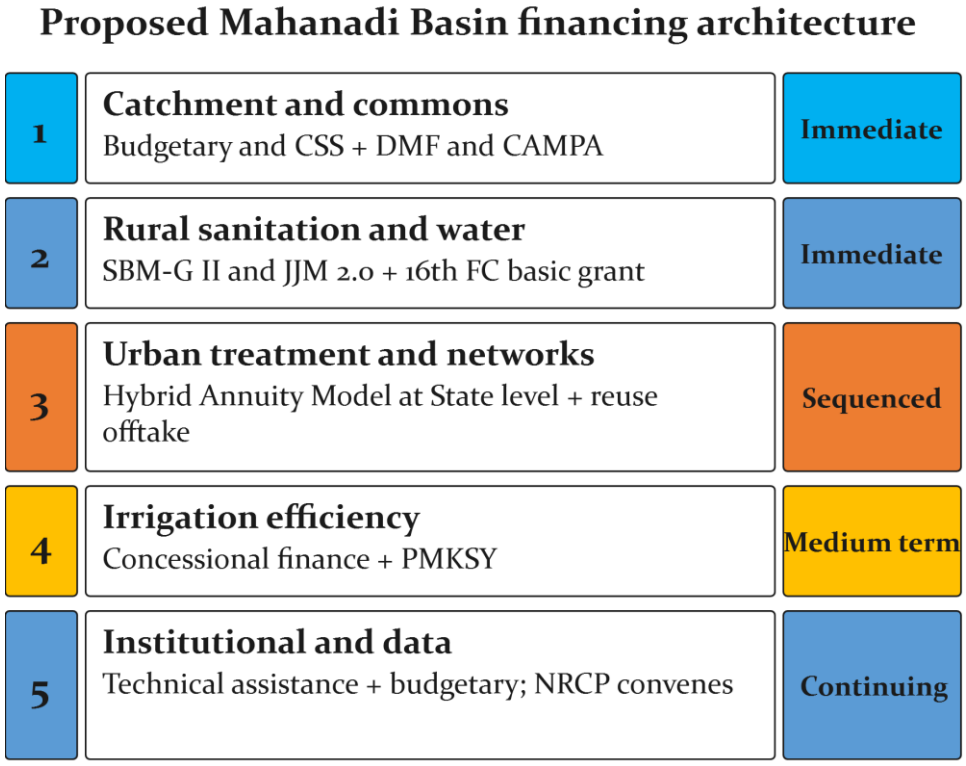


Figure 9 Proposed layered financing architecture for the Mahanadi River Basin

Two features of this architecture deserve emphasis. First, the two layers with the strongest economics and the greatest equity benefit - catchment and rural sanitation - are financed entirely from sources that are available today and require no new institution, no new legislation and no new appropriation. They should not wait for the basin organisation proposed in Chapter 7. Second, the layer requiring the most institutional sophistication is also the one where the basin is least ready, which is why the recommendation for urban treatment is to structure the counterparty at State entity level rather than to wait for ULB creditworthiness that will take a decade to build.

6. Governance

6.1 The constitutional and legal frame

Water is a State subject. Under Article 246(3) of the Constitution read with Entry 17 of List II of the Seventh Schedule, State Governments have the power to legislate in respect of water supplies, irrigation and canals, drainage and embankments, water storage and water power [11]. This is qualified by Entry 56 of List I, which enables Parliament to legislate for the regulation and development of inter-State rivers to the extent declared by law to be expedient in the public interest, and by Article 262, under which Parliament may provide for adjudication of inter-State water disputes and may bar the jurisdiction of the courts - the provision under which the Inter-State River Water Disputes Act, 1956 operates.

The practical effect of this allocation is the defining feature of Mahanadi governance. The basin is a single hydrological system governed by two sovereign legislative authorities, with no standing inter-State executive body and with the Union confined to financing, standard-setting and the constitution of adjudicatory machinery. Every governance difficulty examined below is a consequence of that structure rather than of any failure by an individual agency.

Table 25 Legal instruments governing the Mahanadi River Basin

Instrument	Level	Scope relevant to the basin
Inter-State River Water Disputes Act, 1956	Union	Constitution of the Mahanadi Water Disputes Tribunal; binding effect of its award
Water (Prevention and Control of Pollution) Act, 1974	Union with State boards	Consent to establish and operate; effluent standards; the statutory basis of CPCB and the two SPCBs
Environment (Protection) Act, 1986 and EIA Notification	Union	Environmental clearance conditions, including water allocation and effluent conditions, for the industrial capacity that dominates basin abstraction
Forest (Conservation) Act, 1980 and Forest Rights Act, 2006	Union	Diversion of forest land in catchment sub-basins; community forest resource rights vested in gram sabhas
National Green Tribunal Act, 2010	Union	Environmental compensation; supervision of State action plans on sewage and solid waste [10]
Orissa Irrigation Act, 1959 and Irrigation Rules (amended 1993, 2010, 2015)	Odisha	Irrigation works; basic water rates; licensed allocation of water from government water sources for industrial and commercial purposes, with mandatory flow metering at the establishment's cost [11]
Orissa Pani Panchayat Act, 2002 (amended 2008) and Rules	Odisha	Participatory irrigation management; transfer of tertiary networks and water-rate collection to Pani Panchayats across approximately 18.25 lakh hectares of command [11]
Orissa Industries Facilitation Act, 2004 and Rules	Odisha	Single-window clearance; water allocation to industry cleared by the Water Services Department and reviewed annually against availability, a process termed water rationalisation [11]
Chhattisgarh Ground Water (Management and Regulation) Act, 2022 (Act No. 18 of 2022)	Chhattisgarh	Assented 29 September 2022 and published 7 November 2022; provides for protection, conservation, control and regulation of ground water, with Bhoojal Samitis and a defined class of bulk users [30]. It regulates ground water only, and is not a counterpart to Odisha's surface-water licensing and metering provision
Chhattisgarh surface-water legislation	Chhattisgarh	Continues to rely substantially on instruments inherited from undivided Madhya Pradesh; identified as a

		fragmentation issue in the Infrastructure and Planning Report [21]
Draft River Basin Management Bill, 2018	Union - not enacted	Proposed 13 River Basin Authorities including for the Mahanadi, with a two-tier Governing Council and Executive Board structure, a river basin master plan, and a dispute-settlement role [16]

6.2 The two live developments

The Mahanadi Water Disputes Tribunal. The Tribunal, now presided over by Justice Bela M. Trivedi following the resignation of its previous chair, has had its term extended and has directed the two States to arrive at a mutually acceptable settlement, failing which it will deliver a binding verdict; it has criticised both States for repeated delays and adjournments [15]. Two implications follow. First, the allocation question will be settled, by agreement or by award, within a defined period. Second - and this is the point usually missed - an award settles allocation but does not create a manager. Whatever the MWDT decides will require an institution to implement it, monitor compliance, operate the accounting on which compliance is judged, and adapt to hydrological change. No such institution exists. Creating it is the central recommendation of Chapter 7, and the period before the award is the natural window in which to do so.

The Sixteenth Finance Commission. As set out in Section 5.2, the discontinuation of sector-specific and state-specific grants removes a route through which basin-level funding might have been sought, while the enlarged urban share and the 20 per cent performance component create an alternative route through State-defined performance criteria [6].

6.3 Governance gaps

Six gaps recur across the analysis in this report. They are stated as gaps rather than as failures because each is a structural feature rather than an omission by any agency.

Table 26 Governance gaps in the Mahanadi River Basin

Gap	Evidence	Consequence
No standing basin-scale executive body	MWDT is adjudicatory and finite; River Rejuvenation Committees are State-bounded; Union bodies finance without managing (Chapter 2)	No entity plans, sequences or is accountable for basin outcomes; coordination occurs only through escalation
No basin-level expenditure accounting	No agency reports scheme expenditure against a basin or sub-basin geography (Chapters 1 and 3)	The basin appears under-funded when it is substantially funded but incoherently accounted; convergence cannot be measured
No water accounting or volumetric measurement at scale	Industrial allocation exceeds actual use by an unknown margin [11]; metering powers exist but are not comprehensively applied [11]; municipal metering absent for high-volume users [21]	Allocation decisions are made without knowing actual use; efficiency gains cannot be verified; volumetric charging cannot be implemented

Asymmetric stakeholder standing	The parties bearing basin costs occupy the low-influence quadrants (Section 2.10); Pani Panchayat implementation gaps documented [11, 21]	Downstream, tail-end and fisher interests are not represented in the decisions that determine their outcomes
Local bodies carry responsibility without capacity	SLB findings across 43 Chhattisgarh towns; revenue below operating cost; staff shortages; ₹498 per capita for small towns against ₹4,030 for rural areas [21]	Implementation responsibility rests with the weakest institutional tier; assets are created that cannot be operated
Weak absorption and accounting of earmarked environmental funds	Nationally only 52 per cent of approved CAMPA plan value utilised to December 2024 [29]; in Odisha, ₹210.54 crore of ₹2,284.98 crore unutilised in 2019-22, annual accounts not finalised since 2009, ₹56.82 crore irregularly applied and ₹248.06 crore diverted, and no monitoring or evaluation activity undertaken [28]; identified gaps in DMF planning and utilisation [8]	The largest earmarked environmental funds available to the basin are not converted into works; unspent balances coexist with unmet need, and the absence of accounts prevents any assessment of what the expenditure achieved
Conflicting roles within single agencies	State water resources departments simultaneously allocate water, own and operate infrastructure, and regulate its use (Section 2.4)	Regulatory function is subordinated to operational and revenue objectives; no independent check on allocation

6.4 Roles, Responsibilities and Timelines

6.4.1 Responsibility allocation by function

The matrix below allocates responsibility using the RACI convention: R for the agency that performs the work, A for the single agency accountable for the outcome, C for those consulted, and I for those informed. The discipline of the convention is that each row must have exactly one A. Applying it to the Mahanadi exposes the central problem directly: for several functions, no existing agency can be assigned accountability, and the proposed Basin Coordination Cell or Basin Organisation is entered as the accountable party precisely because the row would otherwise be empty.

Table 27 RACI matrix for Mahanadi Basin management functions

Function	Accountable (A)	Responsible (R)	Consulted (C)	Informed (I)
Basin water allocation between States	MWDT until award; thereafter Basin Organisation	State WRDs of both States	CWC; industry; Pani Panchayats; fisher bodies	Union MoJS; ULBs; public
Reservoir operation and release scheduling	State WRD (Odisha) for Hirakud; State WRD (Chhattisgarh) for upstream storages	Reservoir operating establishments	Basin Organisation; hydropower operator; irrigation	Downstream districts; public

			commands; flood authorities	
Industrial water allocation and licensing	State WRD Water Services function	Executive Engineer; licensing authority	SPCB; Basin Organisation; affected commands	Public through disclosure
Volumetric measurement and water accounting	Basin Organisation (to be created)	State WRDs; ULBs; industrial licensees at own cost [11]	CWC; CGWB; SPCBs	All stakeholders through published accounts
Urban sewage collection and treatment	State urban department (UAD / H&UDD)	ULBs; OWSSB and WATCO in Odisha; concessionaires under HAM	SPCB; NRCD; Basin Organisation	Citizens; NGT through compliance reporting
Faecal sludge and septage management	State urban department	ULBs; SHG and transgender group operators [18]	SPCB; PHED/PR&DW	Citizens
Solid waste and legacy dump remediation	State urban department	ULBs	SPCB; NGT	Citizens
Effluent standards and compliance enforcement	State Pollution Control Board	SPCB regional offices	CPCB; NGT; Basin Organisation	Public through disclosure of monitoring data
Catchment and drainage-line treatment	District administration through District Water and Sanitation Mission	Gram panchayats; forest department; MGNREGA implementing agencies	Basin Organisation; FRA gram sabhas	State departments; DMF trusts
Forest and riparian restoration	State forest department	Divisional forest offices; FRA gram sabhas; joint forest management committees	CAMPA; Basin Organisation	MoEFCC
Irrigation service delivery below the minor	Pani Panchayat / WUA	Pani Panchayat office bearers	State WRD; agriculture department	Command farmers
Groundwater regulation	Unassigned - recommended to State WRD with CGWB technical support	State WRD; district administration	CGWB; agriculture department; industry	Users
Basin data platform and public disclosure	Basin Coordination Cell / Basin Organisation	cMahanadi; State data cells; India-WRIS	All agencies	Public
Scheme convergence and sequencing	Basin Coordination Cell, with State Chief Secretaries	Line departments; district collectors	NRCD; Union ministries	Local bodies

Three rows in this matrix carry no existing accountable agency and are marked accordingly: water accounting, groundwater regulation, and basin data and convergence. These three vacancies are the functional specification for the institution proposed in Chapter 7. The institution is not being recommended because basin organisations are good practice in the abstract; it is being recommended because three necessary functions currently have no owner.

6.4.2 Timelines

The timeline below assigns each action to a horizon, an accountable agency and a verifiable milestone. Short-term actions are those exercisable under existing authority without new legislation or appropriation.

Table 28 Roles, responsibilities and timelines for Mahanadi Basin governance

Horizon	Action	Accountable	Verifiable milestone
Short (0–2 years)	Constitute the Mahanadi Basin Coordination Cell by executive order of both States with NRCD support	State Chief Secretaries; NRCD	Order issued; secretariat staffed; first joint meeting held
Short	Introduce mandatory sub-basin tagging on every water-related sanction in both States	State finance and line departments	Sanction format amended; first annual sub-basin expenditure statement published
Short	Impose sequencing conditions linking treatment-plant tranche release to sewer network progress	State urban departments	Standard sanction condition notified
Short	Ring-fence O&M provision at sanction for all new treatment assets	State urban and finance departments	O&M escrow or committed grant line evidenced in each sanction
Short	Adopt basin service indicators within the Sixteenth Finance Commission performance grant criteria	State finance departments	Performance criteria notified incorporating basin indicators
Short	Programme accumulated DMF balances against a published sub-basin restoration plan in the mining districts	District Mineral Foundation trusts; district collectors	Sub-basin plan approved by each relevant DMF trust
Short	Transfer the Odisha decentralised FSSM and SHG operating model to Chhattisgarh, and the Chhattisgarh Narva catchment model to Odisha	Basin Coordination Cell	Cross-State exchange completed; pilot districts notified in each State
Short	Establish the basin data platform integrating CWC basin, sub-basin and WRD sub-sub-basin layers with scheme, quality and flow data	Basin Coordination Cell; cMahanadi	Platform live; baseline published
Medium (2–5 years)	Establish the Mahanadi River Basin Organisation with statutory backing	Union MoJS with both States	Statute or inter-State agreement in force; Governing Council and Executive Board constituted
Medium	Implement volumetric metering and charging of industrial raw-water abstraction basin-wide	State WRDs	Meters installed at all licensed abstraction points; volumetric billing operational
Medium	Commission HAM or One City One Operator packages for the major basin urban centres with contracted reuse offtakes	State urban entities (OWSSB, WATCO, equivalents)	Financial close achieved; reuse offtake agreements executed

Medium	Establish a basin water accounting system reconciling allocation, abstraction and return flow	Basin Organisation	First published annual water account
Medium	Pilot a Payment for Ecosystem Services scheme in one sub-basin with an identified downstream beneficiary	Basin Organisation; State forest department	Pilot agreement signed; first payment made
Medium	Strengthen Pani Panchayats with volumetric supply at the distributary and real financial authority	State WRDs	Volumetric supply operational in defined commands; audited Pani Panchayat accounts
Long (5–15 years)	Full Integrated River Basin Management with a basin master plan binding on both States	Basin Organisation	Master plan adopted; State plans aligned to it
Long	Groundwater regulation operational in over-exploited and critical blocks	State WRDs with CGWB	Regulation notified and enforced; block categorisation improving
Long	Environmental flow regime defined and maintained	Basin Organisation	E-flow standard notified; compliance reported in the annual water account
Long	Cost recovery sufficient to fund O&M across urban water and sewerage	State urban departments; ULBs	Operating ratio below 1.0 reported by basin ULBs

6.4.3 Monitoring indicators

The timeline above is only enforceable against a defined indicator set. The following minimum set is proposed, chosen so that each indicator is measurable from data that either exists or is created by an action in the timeline.

Table 29 Minimum monitoring indicator set for the Mahanadi River Basin

Domain	Indicator	Source once established
Water quality	BOD at designated basin stations; number of basin stretches in each CPCB priority class	CPCB and SPCB monitoring network
Wastewater	Sewage generated, treated and untreated (MLD) by basin town; septage capacity against generation	State urban departments; SPCB
Solid waste	Tonnes processed against generated; legacy waste remediated	State urban departments
Water quantity	Allocation, metered abstraction and return flow by sector and sub-basin	Basin water account
Catchment	Hectares under drainage-line and catchment treatment; area afforested	MGNREGA, Narva, CAMPA and forest department returns
Groundwater	Block categorisation; pre- and post-monsoon water levels	CGWB and State assessment
Irrigation	Irrigation potential created against utilised; tail-end delivery performance	State WRD; Pani Panchayat returns
Finance	Basin-tagged expenditure by scheme and sub-basin; ULB operating ratio; O&M provision against requirement	Sub-basin expenditure statement; ULB accounts

Equity and participation	Functional Pani Panchayats; FRA gram sabhas exercising community forest resource rights; SHG-operated facilities	State returns; basin data platform

7. Recommendations

7.1 Cross-cutting recommendations

The recommendations below follow directly from findings in the preceding chapters, and each is referenced to the finding that generates it. They are ordered by the ratio of expected benefit to institutional difficulty, not by importance - several of the most consequential are also among the easiest.

R1. Fund catchment treatment first, at scale, from existing sources

Chapter 4 established that catchment and nala treatment is economically robust by a very wide margin, breaking even at ₹572 to ₹758 per hectare per year against a delivered cost of about ₹5,256 per hectare [21]. Chapter 3 established that it can be financed today through convergence of MGNREGA, the Narva component of Suraji Gaon Yojana, PMKSY-WDC, CAMPA and JJM source-sustainability funds, with District Mineral Foundation balances available in the mining sub-basins [8]. Chapter 5 confirmed that no new institution, legislation or appropriation is required. This is the highest-return, lowest-difficulty action available in the basin and it should not wait for any institutional reform.

R2. Structure every sewage treatment investment around a reuse offtake and guaranteed O&M

Chapter 4 showed that a 100 MLD scheme returns a benefit-cost ratio of 0.72 to 0.94 on quantified benefits alone, reaching unity at a treated-water reuse tariff of ₹0.86 to ₹6.23 per cubic metre, and that the result is more sensitive to O&M intensity than to the discount rate. Given the concentration of thermal power and metals capacity in this basin holding allocations of about 2,074 MCM [11], the reuse market exists. Reuse offtake agreements should be a condition precedent to financial close, and O&M funding should be committed at sanction rather than sought afterwards.

R3. Deploy accumulated DMF and CAMPA balances against published sub-basin plans

Odisha and Chhattisgarh hold approximately ₹13,728 crore and ₹7,151 crore respectively in accumulated DMF collections, with at least 70 per cent mandated to high-priority sectors including drinking water, environment and sanitation [8]. They also received the two largest CAMPA transfers in the country in August 2019 - ₹5,933.98 crore and ₹5,792 crore [27] - and Chhattisgarh alone still held ₹2,596.26 crore unspent as on 1 April 2023 [26]. The indicative combined magnitude is on the order of ₹32,000 crore, held in the districts that constitute the basin's most degraded sub-basins. The money is collected, earmarked and correctly located; what is missing is a plan and the capacity to absorb it.

Three specific actions follow. Each relevant DMF trust should adopt a sub-basin restoration plan as the basis for its high-priority sector allocations. Each State CAMPA Authority should re-weight its Annual Plan of Operation toward the Catchment Area Treatment Plan head, which held only about 0.7 per cent of Chhattisgarh's available balance as on 1 April 2023 despite being a named CAMPA activity and despite the catchment economics established in Chapter 4 [26]. And, given the CAG's finding that Odisha's State CAMPA accounts have not been finalised since 2009 and that no monitoring or evaluation was undertaken during 2019-22 [28], restoration of accounts and of an evaluation function should be treated as a condition for scaling expenditure, not as an administrative afterthought.

R4. Introduce sub-basin tagging of all water-related public expenditure

No agency currently reports expenditure against a basin geography (Chapters 1, 3 and 6), which makes convergence unmeasurable and makes the basin appear under-funded when it is substantially funded. A mandatory sub-basin field on every water-related sanction, using the CWC sub-basin layer, is a format change rather than a reform. It is the cheapest single action in this report and it unlocks the measurement on which everything else depends.

R5. Exchange the two States' demonstrated models

Chhattisgarh has demonstrated catchment treatment at scale - 25 lakh structures across 1,995 drains covering 7.04 lakh hectares for ₹370 crore [21] - and municipal solid waste management across all 166 ULBs [21]. Odisha has demonstrated decentralised septage management with capacity exceeding generation, SHG and transgender group operation of 109 of 120 plants, and a revenue-generating service platform [18], together with metered 24×7 urban supply through Sujal and Jalasathi [17]. This exchange requires no adjudication, no reallocation of water and no new statute - only a forum in which to organise it, which is the first deliverable of R6.

R6. Constitute a Mahanadi Basin Coordination Cell now, under existing executive authority

Chapter 6 identified three functions - water accounting, groundwater regulation, and basin data and convergence - for which no agency can currently be assigned accountability. A coordination cell established by executive order of both States with NRCD support can take up the first and third immediately, without legislation. Establishing it before the MWDT award rather than after is the critical sequencing decision, because the award will require an implementing institution that does not presently exist.

R7. Meter and charge industrial raw-water abstraction volumetrically

The legal power already exists in Odisha, where the Executive Engineer may order installation of a flow meter within ninety days at the establishment's cost [11]. The counterparties are few, their ability to pay is not in question, and the revenue can be hypothecated to basin works. This is the only cost-recovery measure available in the basin that is both administratively simple and distributionally progressive, and Odisha should apply it comprehensively rather than selectively.

Chhattisgarh requires a prior step. Its Ground Water (Management and Regulation) Act, 2022 regulates ground water only [30], and no equivalent surface-water metering obligation could be verified from an accessible official source; the draft Water Sustainability Bill that would cover the wider sector is not recorded as enacted [31]. The State should first confirm whether a metering requirement exists in departmental circulars and, if it does not, enact one - either by extending the 2022 Act to surface water or by taking the draft Bill forward.

R8. Give the low-influence, high-interest stakeholders formal standing

Chapter 2 established that the parties bearing the cost of basin degradation - tail-end farmers, fisher communities, delta households and forest-dwelling populations - sit almost entirely in the low-influence quadrants. Remedies: statutory representation on the basin body; volumetric supply at the distributary with real financial authority for Pani Panchayats; recognition and support for Forest Rights Act gram sabhas as catchment managers; and extension of the Jalasathi and SHG operating models, which have already converted this group into paid participants in service delivery [17, 18].

R9. Close the groundwater governance gap

Atal Bhujal Yojana, India's principal participatory groundwater management scheme, operates in seven States, and neither Chhattisgarh nor Odisha is among them [25]. Given that over 80 per cent of rural supply in Odisha and the great majority of Chhattisgarh household supply derive from groundwater, with users in the delta shifting to deeper aquifers as upper layers salinise [21], the absence of a demand-side groundwater instrument is a first-order gap. Either extension of Atal Bhujal-type coverage to the basin States, or construction of an equivalent State instrument, should be pursued immediately.

R10. Commission the six missing studies

Chapter 4 identified six valuation and cost gaps that materially affect basin appraisal, of which the most consequential is the absence of a verified O&M unit cost for sewage treatment - the parameter that decides the economics of the basin's largest capital programme. These are listed with their holders in Annexure A and should be commissioned as a package.

7.2 Institutional Roadmap

The roadmap below is phased so that each phase delivers value independently and creates the preconditions for the next. No phase depends on the resolution of the inter-State allocation dispute, which is deliberate: a roadmap contingent on the MWDT award would deliver nothing until the award arrives, and would then have to begin from a standing start.

7.2.1 Phase I (0–2 years): Coordination without legislation

Institutional form. A Mahanadi Basin Coordination Cell constituted by parallel executive orders of the two State Governments, supported by NRCD and served by a secretariat hosted at cMahanadi. It is advisory and convening; it holds no statutory power and requires none.

Composition. Chaired jointly or in rotation by the two State Chief Secretaries or their nominees, with the Water Resources, Urban Development, Panchayati Raj, Forest and Environment

secretaries of both States, the two Pollution Control Board chairpersons, NRCD, CWC and CGWB representation, and - critically - representation of Pani Panchayat federations, fisher cooperatives and Forest Rights Act gram sabha bodies, addressing R8 from the outset rather than as an afterthought.

Table 30 Phase I milestones - coordination under existing authority

Milestone	Timing	Accountable	Enabling action required
Coordination Cell constituted	Month 0–6	State Chief Secretaries; NRCD	Parallel executive orders; secretariat funding from NRCP administrative head
Basin data platform live with baseline published	Month 6–18	Coordination Cell; cMahanadi	Integration of CWC basin, sub-basin and WRD sub-sub-basin layers with scheme, water quality and flow data; data-sharing agreement between the two States
Sub-basin expenditure tagging operational	Month 6–12	State finance departments	Amendment to sanction and treasury formats
Sequencing and O&M ring-fencing conditions notified	Month 6–12	State urban and finance departments	Standard sanction condition; no legislation required
DMF sub-basin restoration plans adopted	Month 12–24	DMF trusts; district collectors	Technical support from Coordination Cell to prepare plans
Cross-State model exchange completed (R5)	Month 12–24	Coordination Cell	Pilot districts notified in each State; deputation of implementing staff
Basin indicators adopted in Sixteenth FC performance criteria	Month 6–18	State finance departments	Notification of State performance criteria
Six missing studies commissioned (R10)	Month 6–12	NRCD; cMahanadi	Study terms of reference; funding from NRCP or technical assistance

Risks and mitigation. The principal risk is that an advisory body without statutory power becomes a reporting forum rather than a decision forum. Mitigation: give it a small number of concrete deliverables with dates - the data platform, the expenditure tagging, the model exchange - and require it to report against them jointly to both Chief Secretaries. A body that has delivered three tangible outputs has a claim to statutory status in Phase II that a purely deliberative body does not.

7.2.2 Phase II (2–5 years): A statutory basin organisation

Institutional form. A Mahanadi River Basin Organisation with statutory backing, established either under central legislation on the model of the Draft River Basin Management Bill, 2018 - which proposed thirteen River Basin Authorities including for the Mahanadi, with a two-tier Governing Council and Executive Board, a river basin master plan, and a role in settling inter-

State disputes [16] - or by an inter-State agreement ratified by both State legislatures if central legislation is not forthcoming. The second route should be prepared in parallel rather than held in reserve, since the 2018 Bill has remained a draft.

Core functions, derived from the three unassigned rows of the RACI matrix in Section 6.4.1 rather than from a generic template: basin water accounting and publication of an annual water account; basin data and disclosure; convergence planning and sequencing across schemes and States; preparation of the basin master plan; and monitoring against the indicator set in Section 6.4.3. Allocation itself remains with the States, subject to the MWDT award - the organisation implements and monitors an allocation; it does not make one.

Table 31 Phase II milestones - statutory basin organisation

Milestone	Timing	Accountable	Enabling action required
Legal instrument in force	Year 2–4	Union MoJS; both State Governments	Central legislation or inter-State agreement ratified by both legislatures
Governing Council and Executive Board constituted	Year 3–4	Both States; Union	Appointment of members including community representation
First annual basin water account published	Year 3–5	Basin Organisation	Volumetric metering of industrial abstraction (R7) completed; municipal bulk metering
Industrial abstraction metering and volumetric charging basin-wide	Year 2–4	State WRDs	Application of existing licensing powers [11]; equivalent provision in Chhattisgarh
HAM / One City One Operator packages at financial close for major basin cities	Year 2–5	State urban entities	State-level counterparty structure; contracted reuse offtakes
PES pilot operational in one sub-basin	Year 3–5	Basin Organisation; forest department	Identification of downstream beneficiary; monitoring protocol; gram sabha agreements
Pani Panchayats receiving volumetric supply at the distributary	Year 2–5	State WRDs	Measurement structures at offtakes; amendment of supply rules; financial authority devolved
Groundwater instrument operational (R9)	Year 2–4	State WRDs; MoJS	Extension of Atal Bhujal-type coverage or equivalent State scheme

Risks and mitigation. Two risks dominate. First, that legislation does not materialise - mitigated by preparing the inter-State agreement route in parallel from the start of Phase II. Second, that a new body duplicates rather than replaces existing coordination, adding a layer without removing one - mitigated by explicitly transferring the River Rejuvenation Committees' basin-

relevant functions to the organisation and formally winding up the Coordination Cell on its constitution.

7.2.3 Phase III (5–15 years): Integrated River Basin Management

Institutional form. The Basin Organisation operating a binding basin master plan, with State plans aligned to it, a functioning water account, an enforced environmental flow regime, and economic instruments - volumetric charging, pollution-linked charges and payments for ecosystem services - operating at scale.

Figure 10 Institutional roadmap for the Mahanadi River Basin

Table 32 Phase III milestones - Integrated River Basin Management

Milestone	Timing	Accountable	Enabling action required
Basin master plan adopted and binding on both States	Year 5–8	Basin Organisation	Statutory force through the Phase II instrument; State plan alignment
Environmental flow regime notified and maintained	Year 5–10	Basin Organisation; State WRDs	E-flow assessment; reservoir operating rule revision at Hirakud and upstream storages
Groundwater regulation enforced in over-exploited and critical blocks	Year 5–12	State WRDs; CGWB	Block categorisation; regulation notified; community institutions in place

Cost recovery sufficient to fund O&M across urban water and sewerage	Year 5–12	State urban departments; ULBs	Metering; tariff reform with lifeline provision; billing systems
PES operating at scale across upper-basin catchments	Year 8–15	Basin Organisation	Successful pilot; beneficiary payment mechanism; monitoring capability
Basin ULBs accessing capital markets independently	Year 8–15	ULBs; State urban departments	Credit ratings; audited accounts; demonstrated revenue streams (Model C preconditions)

7.2.4 The roadmap in summary

Table 33 Institutional roadmap for the Mahanadi River Basin at a glance

	Phase I (0–2 yrs)	**Phase II (2–5 yrs)**	**Phase III (5–15 yrs)**
Institution	Basin Coordination Cell (executive order)	Mahanadi River Basin Organisation (statutory)	Basin Organisation operating a binding master plan
Legal basis	None required	Central legislation or ratified inter-State agreement	Established instrument, matured
Core deliverable	Data platform; expenditure tagging; model exchange	Annual basin water account; convergence planning; master plan preparation	Binding master plan; e-flow regime; economic instruments at scale
Financing emphasis	Models A and D - budgetary, CSS and DMF	Models B, E and F added - HAM, concessional finance, volumetric charging	Models C, F and G - bonds, cost recovery, PES
Primary risk	Becomes a reporting forum rather than a decision forum	Legislation does not materialise; new layer duplicates rather than replaces	Master plan is adopted formally but not implemented substantively
Independent of MWDT award?	Yes	Yes - implements whatever allocation results	Requires an allocation to be settled

7.3 Concluding observation

The two preceding volumes in this series documented a basin that is well characterised physically and poorly governed institutionally. This volume adds a third finding that should change how the problem is framed: the Mahanadi Basin is not short of money, and it is not short of legal instruments. It is short of an entity whose job is the basin, and of an accounting system that can see the basin at all. Public expenditure of a scale entirely adequate to the basin's needs already flows into it every year through instruments whose purposes are adjacent to river condition; the economics of the highest-priority interventions are robust by wide margins; and the legal powers required for volumetric measurement, pollution charging and community management already exist in one State or the other. What does not exist is any place where

these facts are assembled. That is a small institutional gap with very large consequences, and - unusually for a problem of this scale - closing the first stage of it requires nothing more than an executive order, a data platform and a shared expenditure code.

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Annexure A - Data Requirements

The following datasets and studies were identified during preparation of this report as necessary to close gaps that materially affect basin appraisal and planning. They are listed with the agency that holds or would produce each. Items marked critical are those on which a principal finding of this report currently rests on assumption or benefit transfer.

Table 34 Annexure A - Datasets and studies required to close identified gaps

	Dataset or study required	Holder / producer	Gap it closes
A1	Critical. Verified O&M unit cost for sewage treatment in ₹ per MLD per year, by technology	CPHEEO; State urban departments; NMCG operating data	Decides the sewage-treatment economics in Section 4.7.2, currently assumed at 4–8 per cent of capital
A2	Critical. Scheme expenditure disaggregated to sub-basin for all water-related schemes in both States	State finance and line departments	Enables measurement of actual basin expenditure and of convergence (Sections 1.6, 3.1)
A3	Critical. Metered industrial water abstraction against licensed allocation, by unit	State WRD Water Services; licensees under existing metering powers [11]	Resolves the allocation-versus-use gap that makes all industrial water analysis indicative
A4	Verified per-tonne cost of legacy waste remediation and biomining in both States	State urban departments; procurement records	Completes the decision rule in Section 4.7.4
A5	Site-specific ecosystem service valuation for the Mahanadi delta and Chilika	Chilika Development Authority; research institutions	Replaces the State-scale benefit transfer used in Section 4.6
A6	Contingent valuation or choice experiment for non-use value of the Mahanadi	Research institutions; cMahanadi	Captures the bequest and existence components left unpriced in the Total Economic Value framework
A7	Industrial value added per cubic metre of water, by industry type	State industries departments; industry associations	Enables rigorous comparison of industrial and agricultural water productivity
A8	Flow, fish catch and delta salinity time series	CWC; State fisheries departments; Chilika Development Authority	Enables production-function estimation of environmental flow value
A9	Odisha State CAMPA head-wise fund balance as on the current date, on the format published for Chhattisgarh in [26]; and finalised State CAMPA annual accounts, absent since 2009 [28]	Odisha State CAMPA Authority; National CAMPA	Completes the extractive-industry funds table in Section 3.2.2 - the Chhattisgarh side is verified from [26] but the Odisha head-wise balance, including the Catchment Area Treatment Plan head, is not published in comparable form
A10	ULB-wise water and sewerage revenue, operating cost and non-revenue water for basin towns	State urban departments; ULB accounts	Determines readiness for Models B, C and F
A11	District-wise DMF balances, commitments and utilisation for basin districts	DMF trusts; district collectors	Converts the aggregate DMF figure into a programmable basin envelope (R3)

A12	Sub-basin-wise crop budgets and net returns	Directorates of Economics and Statistics of both States	Enables valuation of irrigation and diversification benefits currently reported as switching values

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